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THE

MINING INSTITUTE

OF SCOTLAND.

TRANSACTIONS,

Vol. II.

1880-81.

HAMILTON:
PRINTED BY WM. NAISMITH, 88 CADZOW STREET.
1881.

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CONTENTS OF VOL. II.

PAGE.

Annual Meeting, 1880, ... 3
New Members, . . 3, 29, 54, 77, 101, 121, 137, 161, 193, 218, 245
Auditors' Report, ... 4
Balance Sheet, ... 5
Report of Council, ... 6
Discussion of Mr G. W. Smith's Paper—"Colliery Shaft Signalling," 8
Discussion of Mr G. B. Begg's Paper—"Notes on Coal Cutting Machinery, ... 15, 62
Ordinary Meetings, . 29, 54, 77, 101, 121, 137, 161, 193, 218, 245
The President's Address, ... 30
Visit to the Works of Messrs Robert Addie & Sons, Benhar, . . 49
Description of Messrs Beaumont and Bicknell's Boring Machine, . 50
The Detection of Gases in Mines, by Mr A. Wilson, . . . 54
Discussion, ... 57, 102
The Lothian Coal Fields, by Mr A. M'Callum, ... 78
Discussion, ... 106
Pumping Arrangements, by Mr W. P. Barclay, . . . 85
Discussion, ... 107
Berryman's Patent Heater, by Mr J. Wright, ... 93
Discussion, ... 113
Reid's Patent Safety Cage and Detaching Hook, by Mr Hugh Strain, 116
Discussion, ... 143
Fife System of Cut Chain Haulage on Inclines, by Mr R. Andrew, . 122
Discussion, ... 146
Notes on Accidents by Falls of Roof and Sides, by Mr J. T. Robson, 124
Discussion, ... 128, 149, 178, 193
Bernheim's Portable Fire Annihilator, by Mr J. Tennant, . . 138
Discussion, ... 139
Dr. Irvine's Safety Lamp, ... 162
Discussion, ... 166
The South Staffordshire Thick Coal, by Mr Robert Calderwood, . 171
Discussion, ... 205
The Transactions, ... 196
Screening, with a Description of a Patent Apparatus, by Mr J. S. Dixon, ... 197
Discussion, ... 200, 219
A Description of Two Modes of Working Thick Seams of Coal in the Wishaw Coal Field, by Mr T. Borland, ... 226
Discussion, ... 238, 246
Haulage, by Endless Rope and Chains, by Mr M. M'Farlane, . 256
Discussion, ... 264

TRANSACTIONS

OF THE

SAN FRANCISCO.

MINING INSTITUTE

OF SCOTLAND.

ANNUAL MEETING, 8TH APRIL, 1880.

HAMILTON:
W. NAISMITH, 38 CADZOW STREET.
1880.

THE MINING INSTITUTE OF SCOTLAND.

ANNUAL MEETING.

THE Third Annual Meeting of the Institute was held in the Lesser Town Hall, Hamilton, on Thursday, the 8th day of April, 1880. In the absence of the President and Vice-President, Mr GILBERT BURNS BEGG, Past President, took the chair.

The minutes of last Special, General, and Council Meetings were read and confirmed.

The following gentlemen, who were nominated at last General Meeting, were balloted for, and duly eleeted members of the Institute, viz. :

ORDINARY MEMBERS.

DUNCAN FERGUSON, Manager, Lohore and Capeldrae Colliery, Lochgelly.

CRAWFORD JAMIESON, Underground Manager, Lugar Iron Works, Old Cumnock.

ALEXANDER ROXBURGH, Agent, Alloa Collieries, Alloa.

JOHN STIRLING, Manager, Banknock Colliery, Denny.

JOHN RODGER, General Manager, Clyde Iron Works, Glasgow.

JOSEPH PRENTICE, Colliery Engineer, Addiewell Colliery, West Calder.

JAMES HODGSON, Engineer, Liverpool Road, St. Helen's, Lancashire.

ARCHIBALD LIVINGSTONE, Manager, The Antrim Iron Ore Co. (Limited), Glencavil, Ballymena, Ireland.

GEORGE BARKER, Mining and Mechanical Engineer, Newcastle-on-Tyne.

The SECRETARY then read the Auditors' report, Balance Sheet, and Report of the Council.

AUDITORS' REPORT.

We have examined the Cash Book of the West of Scotland Mining Institute, as kept by Mr James Gilchrist, and find as follows :

Balance from last year, ...	£6	8	9½
Members' Subscriptions and Arrears, ...	125	17	6
Bank Interest, ...	0	2	6
Received for Advertising in Transactions, ...	10	8	6
Transactions Sold, ...	14	11	7
	£157	18	10½
And the Sums Paid for Printing, Stamps, and Sundries, amount to	140	14	1
Balance in Treasurer's hands, ...	£17	4	9½

(Signed), JAMES SMART, JAMES S. DIXON, } Auditors.

8th April, 1880.

WEST OF SCOTLAND MINING INSTITUTE.—BALANCE SHEET.

Dr. **Cr.**

ABSTRACT OF RECEIPTS.

1879-80.

To Balance from last year, ...	£6	8	9½
„ Subscriptions and Arrears, ...	125	17	6
„ Bank Interest, ...	0	2	6
„ Advertising in Transactions, ...	10	18	6
„ Sale of Transactions, ...	14	11	7
	£157	18	10½

LIABILITIES.

Nil.

Balance, ...	£22	9	9½
	£22	9	9½

ABSTRACT OF PAYMENTS.

1879-80.

By Printing Transactions, Circulars, and Stationery, ...	£105	14	0
„ Advertising, ...	2	6	6
„ Stamps, Wrappers, Post Cards, &c., ...	14	2	6
„ Rent of Lesser Town Hall for Meetings, ...	2	2	6
„ Reporter's Salary, ...	12	12	0
„ Railway Fares, Telegrams, and Parcels, ...	3	16	7
„ Balance in Treasurer's hands, ...	17	4	9½
	£157	18	10½

ASSETS.

By Cash in Treasurer's hands, ...	£17	4	9½
„ Arrears for Advertisements, ...	5	5	0
„ 850 Copies of Transactions (not valued).			
„ 140 Copies Rules, and List of Members' Names (not valued).			
	£22	9	9½

JAMES GILCHRIST, Secretary and Treasurer.

8th April, 1880.

REPORT OF COUNCIL.

THE Council, in presenting their Annual Report, have much pleasure in being able to record the prosperous condition of the Institute, which is now firmly established. The number of Members is now 209, as compared with 46, the number at the close of the last financial year, being an increase of 163. The increase has taken place gradually, and still continues; and the Council anticipate a further increase during the ensuing year.

There have been twelve meetings, including the present, during the year, all of which have been well attended. These meetings have all been held at Hamilton, in the Lesser Town Hall.

It was decided by the Institute, at the beginning of the year, to print the "Transactions." The papers read and the discussions thereon have, therefore, been printed and circulated amongst the members.

The papers read before the Institute have been of considerable interest, and have embraced the important and practical subjects of "Ventilation," "Modes of Working," "Winding," "Coal Cutting by Machinery," and "Signalling." A valuable contribution to the "Transactions" was a description by Professor Forbes of the "Damposcope," an instrument invented by him to detect and measure small quantities of fire-damp in the air of mines. The other papers comprise one on "Trades Unions," and one on "Mining, as pursued in the North of England."

The Institute deputed two of its members to visit and report upon a mode of underground haulage by air locomotives at Newbottle Colliery, county of Durham. The report of the members forms a valuable addition to the "Transactions" of the Institute.

The following gentlemen were then proposed, seconded, and declared duly elected as Office-Bearers and Members of the Council for Session 1880-81.

President:

RALPH MOORE, H. M. Inspector of Mines, Rutherglen.

Vice-Presidents:

JAMES S. DIXON, C. and M.E., 170 Hope Street, Glasgow.
JAMES MacCREATH, C. and M.E., 95 Bath Street, Glasgow.
ALEXANDER SIMPSON, C. and M.E., 175 Hope Street, Glasgow.
JOSEPH T. ROBSON, H.M. Inspector of Mines, Cambuslang.

Ex-Officio Vice-President:

GILBERT B. BEGG, C. and M.E., Brandon Street, Motherwell.

Treasurer:

MICHAEL ROSS, Camp Colliery, Clyde Bridge, Hamilton.

Secretary:

JAMES GILCHRIST, Earnock Colliery, Burnbank, Hamilton.

Other Members of the Council:

JOHN AUSTINE, Coalmaster, Oak Lodge, Hamilton.
JAMES SMART, Coalmaster, Angus Lodge, Hamilton.
DAVID ANDERSON, General Manager, Clydesdale Street, Hamilton.
J. M. RONALDSON, H.M. Inspector of Mines, Pollockshields, Glasgow.
GEORGE W. SMITH, C. and M.E., 123 St. Vincent Street, Glasgow.
ARCHIBALD BLYTH, Bent Colliery, Hamilton.
JAMES HASTIE, Greenfield Colliery, Hamilton.
ALEXANDER JAMIESON, Eddlewood Colliery, Hamilton.
JOHN LOVE, Haughhead Colliery, Hamilton.
JOHN HOGG, North Motherwell Colliery, Motherwell.
HENRY TELFER, Overtown and Law Collieries, Wishaw.
JOHN DRINNAN, Arden Colliery, Airdrie.

Mr J. S. DIXON—Before you go on with the discussion, I think it is only fair, and I am sure all the members will join with me in passing a hearty vote of thanks to the retiring office-bearers, and especially to Mr Gilchrist, secretary, because there is no one knows, except those who have tried it, the amount of work that falls upon the secretary. (Hear, hear.) I have had a little experience in that way, and know what it is. The duties are very arduous, and they are sometimes not altogether appreciated; and I think the least we can do is to give Mr Gilchrist a special vote of thanks for the great trouble he has been at during the year. (Cheers.)

DISCUSSION ON MR SMITH'S PAPER.

The CHAIRMAN (Mr Begg)—There was considerable discussion on Mr Smith's paper at last meeting, but I do not think the views of the members were altogether exhausted, and I am sure that Mr Smith will look for a full discussion to-night.

Mr G. W. SMITH—Mr Hogg asks, at page 310, "In the case of where two or more seams are working, how does the engineman know which bottomer is signalling, seeing there is only one bell?" With the present system in use, I can see it is important the engineman should know that the landing, where the cage is, is clear before lifting away to another. With this system, the signals, 4, 5, or 6, as the case may be, indicates to the engineman the particular landing or seam where the cage is to go to. Till the danger signal is off he has no right to stir, but the moment it is, he can be sure that all the entrances or landings are safe to move his cage away, so that in this way he can suit himself as to which cage is to go to the landing, without its being absolutely necessary for him to know from what landing the signal came.

Mr Austine (page 312) thinks if the bottomer made a mistake and put something wrong, he might alter the signal and put the blame on the engineman. Till the bar is down, there is no message conveyed; once it is down and the message sent, and the

cage goes up instead of down, or *vice versa*, the bottomer can stop it instantly and reverse its motion by using the signal lever without disturbing the first signal. I think if any accident occurred from a wrong movement of the engine, the bottomer would be so sure he was right and the engineman wrong, he would not seek to cancel it, till he got a bell signal from the surface to go on again as before. The practical advantage of getting at who was to blame is this—Should an accident have occurred, the blame might be put on the signals when in reality it was some defect in the engine gear or brake, or the low pressure of steam, or something foreign to the signals altogether. Instead of having the defect remedied at once, the engineman may go on working till he gets an opportunity of putting it right. So that if it could be definitely proved (as this indicator would prove) whether it was the signals or not, the source of the error could be traced and set right, and for this reason the signal is made a locking one so that the engineman cannot alter it.

Some discussion took place (pages 312 and 313) about making a signal two and then one, in contra-distinction to a signal three. It might be further explained that if the protection bar is not down when the bottomer signals one after having signalled two, it registers three on the indicator. If the protection bar is down, he cannot make that signal anything else than two by "belling" again ; the protection bar going down is the full stop at the end of his sentence. Mr Morrison asked further how to stop the cage after having signalled two; and, as already explained, this is done by the side lever, as usual, by "belling" one.

The President (page 314) advocates sight signals in preference to sound signals. When there is only a choice of using one of the senses, I think the sense of sight is preferable to the sense of sound ; but with the monotonous work of winding all day the senses are apt to get benumbed. I have been told of enginemen falling asleep at their post, and of others starting their engine *without* a signal; and so I think every means should be used to keep the faculties on the alert. My theory is that sight and sound together for signals is better than either singly, the one checks off the other.

B

The President (page 315) thought it would be desirable that the engineman should know he was wanted at No. 4 as soon as he was away from No. 1. This was quite requisite in working the Incline signals. The bevelled bogie truck had three decks, and the engineman got one hutch only at each level, and so it was quite necessary he should know which level to go to for the next. But with a vertical shaft, when the cage gets its load it doesn't stop as a rule till it gets to the surface, and before the hutches are changed the new signal to go to No. 4 is given, which for all practical purposes is soon enough.

Mr Robert Waddell (page 317) suggests a combination of the Incline signals with this new Indicator. Since last meeting, I have introduced a small box signal, as on the Inclines, to work in conjunction with these signals. Each seam has its corresponding weight in the box with its name marked on. When at any seam a man is desirous of bringing the cage to that seam, he, by means of a lever and wire, allows the weight representing that seam to drop in the box, when the engineman will bring the cage to that landing. This, I think, will meet Mr Russell's objection to slack chains (on page 319), as in this case no protection bar would be lifted till the cage is opposite the respective landing. By this means any number of seams could be worked with one bell without any difficulty.

At pages 319 and 320, the President advocates having one signal for each door or landing. Where these signals are in operation there has been no want of this sort felt; but should such a difficulty arise, I think Mr Waddell's suggestion would be a solution of the difficulty, as by using the box signals to *bring* the cage to a special landing, and the Indicator for *despatching* it to the surface or any mid seam, the elements of safety in this system is not done away with, which would be the case if the box signals were used alone. The engineman's wire to the bottom could be utilized for this purpose, but if thought advisable a separate wire could be introduced.

The CHAIRMAN—Mr Smith has evidently thought the matter thoroughly out, with the view of meeting all the objections urged. This alteration—adding a sight signal to the bell—has met the objections of some against the signals, and, I have no doubt, that

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many of you may have questions to put on this point. There is one thing I would like to ask: Is that additional signal worked by an additional lever or not?

Mr SMITH—It is worked by an additional lever.

Mr SMART—Has it an additional wire?

Mr SMITH—The wire the engineman uses for repeating the signal down the pit could be utilised for that purpose.

Mr ROBERT WADDELL—Before the discussion goes further, I may be allowed to point out that at p. 317 I am reported to have said quite the opposite of what I did say, but Mr Smith has quite understood what I did say, and I see acted on my suggestion. I am represented as stating—"Would it not do to have a combination of three signals so that they could not communicate." Of course "three" was never spoken of. What I did say was—"Would it not do to have a combination of *these* signals, so that at the different bottoms they could commnnicate with the engineman."

Mr SMART—Does the separate wire—the engineman's wire—interfere, in any way, with his signal?

Mr SMITH—No.

Mr BAIRD—Mr Smart, this is a little bit of wire attached to the engineman's wire in the engine-room from the engineman's wire to the top of the indicator.

Mr SMART—Oh, yes.

Mr BAIRD—It requires that extra wire, and when the engineman pulls his wire it does not affect the weight in the box at all

Mr WADDELL—Does the bottomer require, while pulling that other signal down to—say "the rise doors"—does he again require to go to that other lever and put it back again?

Mr BAIRD— Oh, yes.

Mr WADDELL— I would suggest, in putting down the levers and finishing his bell signal, that it be made to adjust the disc, so so as to put it in its normal position.

Mr BAIRD—I do not see anything to prevent it.

Mr WADDELL—Would that not be an improvement?

Mr BAIRD—Yes, it would.

Mr DIXON—The protection bar is raised on the lever; it looks as if it were raised on it to knock it down.

Mr SMITH—It was not intended so, but it could be worked with only one lever.

Mr WADDELL— It could be cancelled anyway with the one, which would put things in the proper way again.

Mr SMITH—Yes.

Mr BAIRD—I do not see any good of attaching it at all, because if the bottomer is there waiting for a cage, why, he is attending to that lever, and so soon as he sees the cage he just puts it up. He is doing nothing else, he is just waiting on it.

Mr WADDELL—He might forget to cancel it.

Mr BAIRD—Although he should it does no harm.

Mr WADDELL—It does harm, for it shows he is needing it again.

Mr BAIRD—If no one is there it does no harm.

Mr WADDELL—As soon as he is finished with the cage, I think it better that it should be cancelled.

Mr BAIRD—I don't see, for you must give a man something to do. I think he is better to be busily employed and looking after his work.

Mr DIXON—It does not do it any harm the other way. It amounts to this: Instead of throwing it down, you raise it up, and when the bar comes down it would fall on it and cancel it.

Mr GILCHRIST—It might answer in some cases, but I know others where you would require another wire for the weight signal, it would not work both.

Mr SMITH—At each colliery the details would require to be worked out to suit the special requirements of each case. What is shown now is merely a general idea of the whole.

Mr BAIRD—I would like to know how it would not suit in any bottom or any pit. It would suit in any pit I have ever been in.

Mr GILCHRIST—I could have shown you one to-day where the signal wire to the bottomer could not be utilized for the sight signal. Perhaps it is a bad arrangement, but up to the present time it has given every satisfaction.

Mr BAIRD—What is the obstacle?

Mr GILCHRIST—It is the sight signal I refer to, not the Indicator bell. I say you would require a separate wire for the sight signal. That wire (pointing) would not answer the purpose.

Mr BAIRD—If you have got the wire to the bottom it would do it.

Mr FAULDS—What Mr Gilchrist means to say is this—the engineman in signalling to the bottom causes the wire to be tight, and in making that sight signal you have to pull it, which could not be done.

Mr BAIRD—But the wire would go both ways.

Mr FAULDS—It depends on the way it is set at the surface.

Mr SMITH—The lever handle should stand out square to the line of the shaft, so as to be clear if worked from the bottom or surface. (Illustrates point on model.)

Mr FAULDS—The placing of the iron handles as suggested by Mr Smith would, on the engineman signalling, work very un satisfactorily.

Mr RONALDSON—There is one thing I want to bring before your notice. At the top of p. 302, Mr Smith says : "Although the outputs," &c. When I read that, I inferred that he meant that shaft accidents are as frequent now as long ago. Anybody who looks at the annual reports will find that the number of shaft accidents has decreased, and especially since the present Mines Regulation Act has been in operation. In the West of Scotland district these accidents have gradually decreased from 19 in 1872, till last year they were down to 5. I believe this is greatly owing to the use of safety gates. Mr Smith informs me that he does not mean this ; but my impression on reading his paper was that he meant that shaft accidents have not diminished in number.

Mr SMITH—I am sorry if I have conveyed that idea to Mr Ronaldson. What was intended was that little had been done for signalling, notwithstanding increased outputs and speeds.

Mr ROBSON—I would also point out that the table of accidents which Mr Smith gives includes all the accidents that happen in sinking pits as well as in winding shafts. A large proportion of them happen in sinking shafts, and probably many of these are accidents which neither this system of signalling nor any other could prevent. They are accidents quite different from those that happen in ordinary winding pits.

Mr HOGG—In connection with a remark Mr Morison made at

last meeting; suppose that just as the cage is starting, the bottomer sees need for stopping it, and signals one for the engineman to stop. He hears the bell, but it does not alter the indicator; so I suppose the tell-tale is done away with—that is to say, the engineman hears the signal, but if he goes on and an accident happens, does Mr Smith say in this case there is any tell-tale?

Mr SMITH—In this case, ringing one to stop the cage after it has started leaves no tell-tale: but there is always the pithead hammer, which strikes simultaneously with the indicator bell, if further evidence be wanted that the bottomer ordered him to stop.

Mr HOGG—The tell-tale is one of the improvements; but in this case you admit there is no tell-tale?

Mr SMITH—It is an exceptional case. If the engineman had gone up instead of down, and an accident occurred in consequence, if you shift the tell-tale from the original signal, you destroy the evidence as to the engineman's mistake. He could not have any motive in disregarding the second signal to stop his cage—it would not help him in any way out of his first error.

I should like to ask Mr Russell whether this signal-box, after the model of the Incline signals, I have added to this Indicator since last meeting, meets the difficulty he had in regard to slack chains, &c., spoken of at last meeting?

Mr RUSSELL—I may say, Mr Smith, it has fully met the difficulty I had to it at last meeting, and I must say it is pretty well done.

Mr FAULDS—Might I ask some gentleman in the room, who has seen the Indicator at work, to give his opinion of it?

Mr HOGG—In the absence of any who may have it working, I happened to be at a place lately where Mr Smith's Indicator is in use. I asked the engineman, the oversman, and some other people concerned, their opinion, and they said the hutches could be put on and the signalling done quite as speedily as with the old system. That was my only objection to this mode; but it is now done away with, because the signalling can be made quite as fast with Mr Smith's system as with the ordinary.

The CHAIRMAN—Well, gentlemen, if there is no other observation, I think I am fulfilling a duty that you will all consider

absolutely necessary, in conveying to Mr Smith a very hearty vote of thanks for his interesting paper, and no less simple and interesting models that he has exhibited. The signals that Mr Smith has invented have been before us for some time, and I had considerable difficulty in understanding them. Even now, I confess, had it not been for the models and Mr Smith's explanation, I would not have fully understood them. I can say they meet a great many grievances that the old system of signalling gave rise to; and, I am sure, whether we come to adopt them or not, we are heartily indebted and greatly obliged to Mr Smith for his explanation of the signals, and the trouble he has taken to meet all objections.

DISCUSSION ON MR BEGG'S PAPER.

Mr Begg having demitted the chair in favour of Mr Robson,

The CHAIRMAN said—Mr Begg's interesting paper was partially discussed at last meeting, but by no means exhausted. I think we should take it in parts as he has divided it, and if any gentleman has anything to say the meeting will be very glad to hear him. I myself went over Mr Begg's calculations of the cost of cutting the coal, and I think he has rather understated it. He gives it at $1\frac{1}{11}$d. I think it should be 1·9d—nearly 2d for Rigg and Meiklejohn's machine per yard of face cut. This is purely a matter of calculation, taking it on the basis given, but perhaps Mr Begg will explain the matter.

Mr BEGG—No, I cannot explain that.

The CHAIRMAN—The cost with the Baird's machine I made out to be nearly 4d—the average of the two machines, 3d. You put it down at 2d.

Mr BEGG—I did not bring my detailed notes with me, and I really cannot off-hand check these calculations now. But I am certain that the figures, as I have stated them, unless we have varied in the system of working out from the data, are correctly enough done, and I have made ample allowance for friction in the estimate of the horse power, which has kept the effective

horse power, on which the cost is calculated, low. Without having the details of my calculations to go over, I can say nothing further now.

The CHAIRMAN—Well, both Mr Ronaldson and myself went over them, quite unknown to each other, and compared notes in the room when the meeting was going on, and our results were precisely the same.

Mr BEGG—I will have the matter examined and put right before the next number of the Transactions is in the members' hands, and if the difference we make is so much as really to be doubled in one case, of course it will make a serious alteration on the views the different members may take of it. But I have no objections to take it, as in the meantime established, that my figures are wrong, and I will adopt Mr Robson's, which are nearly double—instead of 1d for Rigg & Meiklejohn's, and 2d for the Baird's machine, the cost for power only will be 2d for Rigg & Meiklejohn's and 4d for Baird's per yard for wall cutting. It wont matter on the merits of the discussion, although it affects the care with which I worked out my calculations.*

Mr DIXON—At last meeting I made a few remarks all tending to this—to ask some person, who had a real practical knowledge, of the exact saving as between machine working compared with hand labour, and I did not get an answer to that. Mr Begg's figures are to a certain extent founded on theory. Now, these machines are out of the region of theory; they have been working for years, and there are men who can, to a farthing, tell the cost of a certain number of walls with these machines, and a certain number with manual labour, and I want to know what is the difference.

The CHAIRMAN—Would Mr Grant oblige us with a few remarks bearing upon that particular point—comparing a range of walls worked by hand with a similar range worked by the machine?

Mr GRANT—It is just like 60 to 90. Sixty men at a machine can do as much as ninety at a coal face.

Mr SMART—It is a third more.

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* On subsequent examination, I claim that my figures are absolutely correct, and that Messrs Robson and Ronaldson must be in error in their observations.

Mr BEGG—It is a half more—50 per cent.

Mr DIXON—Well, in my remarks at last meeting, which were founded on a cursory visit I made to Bothwell Park Colliery, I said the difference was as three to four in the output per man at the face, as far as I could make out. To that you have to add the cost of power and interest on capital, redemption of capital and those other charges. I made the difference in the actual cost per ton to be very little indeed, and as far as I can see really the whole difference resolves itself very much into a saving in dross and having fewer men to manage. I would like to be corrected if that is not the case.

The CHAIRMAN—There is one point in the paper upon which we must ask further information from Mr Begg. Mr Begg says he cannot afford to have any more roads because of the expense of the buildings, and yet he shows a saving of nearly a shilling a ton. How do you reconcile these statements?

Mr BEGG—That is bearing on the system I propose for working out the ell coal. The cost is altogether in the expense of the buildings, and if I have to put these, as Mr Dixon proposes—viz.: to double them, because he says instead of having the walls at 35 yards they would require to put them in at 17 at the most, and thus doubling the expense of building—the profit I show must disappear at once and entirely. But take the discussion fairly. Mr Dixon has, in addition to the figures he has given of the estimate of the saving, proceeded to take exception to my plan of working out the ell coal on two different points. First of all, that it was so complicated; and, next, in the width between the roads I propose for the machine stalls. Now, the width of these roads altogether rests on the ability to fill the coal into tubs in the face. If there be height to fill them, and room enough to lead your tubs up and down the wall face, we are entitled to take advantage of that and have fewer roads, especially as they have to be constructed of substantial and expensive building. I do not think I overstate the case when I claim that three roads could work out a wall of 100 yards in width easily enough. Then Mr Dixon has another objection to the application of the plan. He says that a wall of 250 yards in length would produce an output of 500 tons. It is quite true, but in the ell coal does he contem-

plate a straight wall in one continuous line of 250 yards? I may say that I would dread such an experiment. It is too long and too straight, and I do not think it could possibly be got to stand. Therefore I fall back on my plan of breaking it up into shorter lengths. Then to suit his way of working it, the field must be very narrow, else, in addition to the cost estimated for, he must allow something for brushing, as his roads wont give height enough to carry on this style of working for any greater distance than I have proposed. The method I propose in the paper needs no brushing of the roads whatever, the first building being sufficient to carry you up to the end of the machine wall. When you are done with it entirely, all further expense is unnecessary. The merit of the break by short walls is this, that if a crush should come on it only affects a very narrow section of the pit. Further, by the method I have proposed, I can put six or eight machines at work as readily as two, whereas, according to Mr Dixon's method, at the very most you could only have two—one at each side of the pit, taking out a strip each. Then, the importance of the saving is increased, when you come to consider that, in opening up the field, you have made stalls with roads already provided through the solid, on which the machine could work backwards. Now, to take up Mr Dixon's figures, and the saving as he estimates it, I have failed to see what he would be at except it is that he wishes people who are getting any benefit by use of a machine to come and tell him, "Look here, we are saving so much; come you and do the same." Is that a likely thing to happen? Let him and every one of us face the matter, and it resolves itself into this that a machine can hole a wall of coal; it cannot work stoop-and-room I grant; but it can hole a wall of coal and that is all it does—that is to say, the men at present occupied in holing a face of coal find their "occupation gone" if it is done by the machine, and these men are then free to do something else. Does it not then stand to reason, without any theory, that the saving is just the difference between the cost of sending a machine to work for the shift and the number of men required to do the same work? Now, let us think what that amounts to. A machine—I am perfectly safe in claiming what it does every day in practice—shall quite easily cut

25 or 30 yards in an hour, holing 3 feet in. I certainly think, though my own knowledge does not enable me confidently to assert, that 30 yards or so would not be done by hand in that time without the assistance of thirty men. I have never gauged it in any way, but if a machine could do in this way the work of thirty men, is that not the correct measure of saving? I don't think there is much theory mixed up in the question. Of course theory does appear in this paper, because I have worked out certain figures from statements given me of the pressure of the air and a statement that compressed air can be produced for such machines at a cost of 4d per horse power per hour. So far theory is mixed up, but I think it is rather a question of mere judgment and comparison of one quantity of work with another, and have advanced it on these grounds.

Mr RONALDSON—I would like to ask Mr Begg a question regarding his building. He says he has no brushing in this proposed method of working the ell coal, and that the building consists of old wood and afterwards of stone obtained from the waste. How does he get hold of this stone out of the waste, and how does he propose to build it up? Perhaps he will give the details of that?

Mr BEGG—Well, I have shown a little bit above where Mr Ronaldson has drawn attention to, viz., in page 276, that "In first commencing" (reads). You get a break in this way brought on the machine wall, and it follows you up, and from these falling stones you obtain material for your building. I don't see much difficulty in it.

Mr RONALDSON—Do you take the stones out from behind your line of chocks along the coal face and carry them down the road?

Mr BEGG—Just at the back of the wall, at the corner.

The CHAIRMAN—You mean that you take the stones from the cundies?

Mr BEGG—Exactly what would be called the cundy.

Mr SMART—And the roof is broken with chocks?

Mr BEGG—Yes.

Mr SMART—If you had a separate roadway it would be a saving of 30 yards, and you would have a communication from that without any building.

Mr BEGG—I beg your pardon.

Mr SMART—We would suppose when you start, you start with three roads leading up on each side of the panel you intend to work. Of course you would lose the road next the panel, but you would have a drift going through to the second road, and you would leave a sufficient stoop to protect your roof so that that would always be kept entire and your air would go right up.

Mr BEGG—According to the plan shown you have the drifts in each panel here for whatever method of haulage or ventilation is adopted.

Mr SMART—I would have no road there. That road requires to be maintained. I would call this my road (pointing) and bring them up here.

The CHAIRMAN—I think what Mr Smart wants to know is, do you utilise these openings through the coal on each side of the machine wall for drawing roads from the machine wall, or do you draw all the machine coal down the waste roads?

Mr BEGG—Down the waste road.

Mr SMART—I did not propose having any waste roads. I would have this (pointing) as my drawing road.

Mr BEGG—Mr Dixon, that is an answer to your objection. Mr Smart thinks instead of having them at 35 yards the roads should be taken away altogether, and only—

Mr SMART—That is provided the strength of your chocks is sufficient to break your roof.

Mr DIXON—I would be most happy to see it done. That is my difficulty.

Mr BEGG—And my difficulty too. I do not see how we could manage it, Mr Smart.

Mr SMART—If you had timber pillars, and kept the pillars and roof safe for the machine.

Mr BEGG—Well, that is three feet. To draw all this output of coal down the face you must have at least a double road.

Mr SMART—I would propose a road on each side.

Mr BEGG—Clearly, but out of these you have nearly 120 tons going, and all that down the face. Instead of one road of three feet, you would require a double road at the very least, and very possibly a lye in the gullet.

Mr SMART—That would depend upon the width of the gullet.

Mr BEGG—I do not think it would be possible.

Mr JAMIESON—Is there not a difficulty in getting these chocks out after the weight is on?

Mr BEGG—I am told not.

Mr JAMIESON—Do you put in one set before you draw the back one?

Mr BEGG—Clearly. Three sets of chocks are used. The one is set up next the face before the waste row is drawn out; and I think the face advancing so rapidly as it does by machine working would facilitate very much the drawing of these chocks, and at the same time ensure the full breaking of the roof.

The CHAIRMAN—The difficulty would be that with a strong roof it would not break off readily, and with such a great distance between the buildings when it did break it might fall to the coal face.

Mr BEGG—Not over the chocks.

Mr DIXON—I suppose I will be allowed to say a few words in reference to what Mr Begg has said. Mr Begg, and I think the meeting generally, has an idea that I am antagonistic to coal cutting by machinery. I am the very opposite, but I want to elicit information, and I think, with regard to these machines, as far as I have seen, that their real merit is in the fewer number of men and the saving of coal, but I want to find out the exact saving in pounds, shillings, and pence. Mr Begg says no one would be so foolish as to give this. If it would be foolish then I am very foolish, for I have given a great deal of information in regard to many mining matters, and given it in the exact pounds, shillings and pence, and I think other folks should reciprocate such information. (Applause.) In regard to the plan, Mr Begg says he has made room for five and six machines working. At last meeting, I merely threw out a cursory remark as to the circumstance that in a six feet seam of long-wall a face of 250 yards could yield an output of 500 tons per day, and two machines would undercut this. I do not see the use of having five or six when two could do the whole. I would be most happy to see a plan to work the ell coal long-wall without brushing——

The CHAIRMAN—It is for the meeting to find fault, if there be any, to the proposed plan.

Mr DIXON—In practice, to clear the coal from the machine, it requires a road every 11 or 12 yards. How does Mr Begg intend to work back the stoops with a long-wall face? If he can show me how to do that, then I can show him how to work the coal to great advantage, because you would require no brushing with that method.

Mr BEGG—I would fain solve Mr Dixon's difficulty in the cutting back these panels, but I must say I do not see where his difficulty is. You cut up to the top of the machine walls working forward, and you leave the solid panel between.

Mr DIXON—It is not solid. That is the difficulty.

Mr BEGG—Well, if you have to make all these openings that I have shown, of course it would not be solid. I had nothing special in view in making all the openings shown on the plan further than to meet every possible requirement. I inserted a double road for haulage and another on each side for ventilation. Meeting all these objections, I may have put in more openings than shall be found necessary in practice. At the same time, it is not the up and down, but cross drifts that would offer any obstacle to the machine working. These cross drifts you can regulate to your own opinions or requirements, and if you can work up your panel in the solid with fewer of those drifts than I have shown, so much more chance have you in working it back successfully. Certainly with the machine in coming to the back of a stoop there is considerable difficulty, and, as I said in answer to Mr Dixon before, at Auchinraith, it has been found impracticable to work out the whole of the stoops—a little bit of each had to be taken out by hand. To avoid a part settling down on the machine and jamming it, they worked to edge of stoop, within six feet or so, and then removed the machine and took the remainder of the stoop out by hand. I see no difficulty in working out these panels, following the same method, and taking care to break band with the drifts as much as possible, so that you would not have the whole width of the panel to take out by hand at one time. With the heading drifts I see no difficulty whatever.

Mr DIXON—As far as I see that plan of working should be quite as applicable to ordinary stoop-and-room workings; but I really do not see my way to work back stoops with a machine.

The CHAIRMAN—To work back stoops with a machine?

Mr DIXON—That is practically the same thing. It is a stoop-and-room working in every sense of the word.

The CHAIRMAN—If he left out the side rooms and confined the work in the solid to the mere driving of a pair of headings for access to the rise coal, would that not make it better? The side places are not absolutely necessary to the system.

Mr DIXON—The great difficulty to be overcome is to avoid the expense of brushing. This can best be met by driving places to your march and working back.

Mr SMART—There is one thing I am not very clear on. In answer to Mr Dixon's question, a gentleman stated that the difference between machine and manual labour was 60 to 90. Do you get 90 tons of coal put into the hutches by a machine at the same cost as 60? Am I to understand that?

The CHAIRMAN—That is how I understood it. It is 1½ to 1—33 per cent. cheaper by machines for labour alone.

Mr DIXON—The gentleman said 90 men to 60.

Mr SMART—That did not cover the machine expenses.

Mr DIXON—It amounts nearly to what I said at last meeting. If a shilling a ton were paid for digging and filling the coal by manual labour, according to what Mr Grant has said, it would take 8d to fill the coal from the machine.

Mr SMART—And then you have the expense of up-keep of the machine.

The CHAIRMAN—Yes. The balance is a set-off to the machine.

Mr HASTIE—I do not see how Mr Grant could answer the question put to him. The machine has never been tried in the ell coal.

The CHAIRMAN—Mr Grant did not answer it as to the ell coal.

Mr HASTIE—Yes; it is the ell coal he is on at present.

The CHAIRMAN—We are anxious to get as much information as possible. We cannot get any actual facts to-night as to the ell coal; the only available information is as to the splint.

Mr HASTIE—Certainly; according to what Mr Dixon has said I quite agree, unless additional figures are available, as far as the ell coal is concerned hand labour is the best. I will not say for the splint coal.

Mr MACFARLANE—On 26th March, through the kindness of Mr Grant, I was allowed down to see the machine at work at Bothwell Park. I did not go into the cost of the machine; I merely went along the face and saw it working, and I thought it worked very well and was doing good work. I had not a great deal of time, but I measured off 30 feet along the face of the main coal seam, which is four feet high, and while I was looking at it I thought it was working wonderfully well. I was so well pleased with it, I was determined to see in what time the work could be done. Well I measured off 30 feet, and in the course of the work the machine left the rails. I turned to the man in charge and said, "I hold you for all those mishaps." Well they got it on the rails again, and away they went; and I think they holed 29 feet in length, 3 feet in, and 2½ inches high in 15½ minutes. Well, I came to the conclusion that the dross made was a just test, and, as far as I could calculate, there would be 12 cwt. in the distance holed. Very well, taking the same amount for the miner, it would take him to make this four days, and the average dross would be 2 ton 3 cwt. This is not all, for the miners in practice do not hole 3 feet in nor anything like it; 15 inches, and putting a wedge in, and so on is about it. This shows us the machine throws a great per centage less of dross, although, I admit, the dross it makes is useless; so that I approve of the machine as far as I have seen it working.

The CHAIRMAN—Do you mean it is not much cheaper per gross ton, but there is a decided advantage in the larger proportion of round coal?

Mr MACFARLANE—I say it must be a great deal cheaper considering the amount of round coal. I have not gone into the cost of the machine, but I am telling you the work done at the time.

The CHAIRMAN—Yes; anyone can make it out for himself.

Mr HASTIE—Was this 30 feet holed clean off the pavement?

Mr MACFARLANE—The machine on the outer side was so lifted that the cutters went down to the pavement. At the back there were from 2 to 3 inches, and that was knocked off with the shovel as they came back.

The CHAIRMAN—That 2 or 3 inches would be dross?

Mr MACFARLANE—Yes.

Mr DIXON—It seems to me that the difference that we have brought out between manual labour and the machine is too small a difference. I think the amount that the machine should put out should be more than in the proportion of six to nine ; therefore, our object should be to try and invent some machine to make the coal easier got after it is holed. I think what is wanted is something like a plough, which could be put in at the back of the three feet holed to act like a coulter, so as to shove the coal to the road head, where a man might be standing to fill the hutch. That is a hint to work upon.

Mr GILCHRIST—Mr Dixon said they had found it absolutely necessary, both at Bothwell and Auchinraith, to have roads every 10 or 12 yards. I presume he means if a greater distance were between the roads, the men would not have the coal removed in time. This is in a 5 feet seam, so the quantity of coals between the roads is from 15 to 18 tons. Well, yesterday, I had a letter from Mr Smith, who read the paper on a Staffordshire mode of working long-wall. He was questioned very closely on the amount of coal they could fill at the face there ; and his answers perhaps were not as clear as some would have liked. He appears to have given the matter greater attention, and he writes me saying he finds two men can fill 34 tons of coals in eight hours. He says that the way they fill the coal is : they have a basket and rake, and with the rake they draw about half a cwt. of coal into the basket, so that they lift 56lbs. every time, and throw it into the hutch. Is not this a much better way than lifting it with a shovel or piece by piece? And Mr Smith thinks if this were adopted we would be able to fill a greater amount of coal here.

The CHAIRMAN—I was going to say Mr Dixon's theory might have gone a little further. It ought to have filled the coal as well,—scooped it up, and emptied it like a dredger.

Mr GILCHRIST—If he turns his hutch up the face he does not require to bring the coal to the road-head after he gets it brought down.

Mr DIXON—In Yorkshire they work with 60 yard walls, but they have small hutches. They work a seam of 5 or 6 feet thick, and they are unable to top their hutches. This is a great difficulty,

and I have studied the question of long faces to see if we could not adopt it, for in many ways it is a great advantage.

Mr GILCHRIST—The system explained by Mr Smith is adopted generally in that district, and they are as well filled hutches as any in the district. They drag it on end.

Mr DIXON—That is perhaps a way out of the difficulty.

The discussion was further adjourned.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING, 13th MAY, 1880,

IN THE

LESSER TOWN HALL, HAMILTON.

RALPH MOORE, Esq., President, in the Chair.

The SECRETARY read the Minutes of the Annual Meeting and the Minutes of the Council Meetings.

The following gentlemen, who were nominated at the Annual Meeting, were balloted for, and duly elected members of the Institute, viz. :—

ORDINARY MEMBERS.

THOMAS GIBB, Manager, Dalzell Colliery, Motherwell.
ROBERT WILLIAMS, Coalmaster, Camp Colliery, Motherwell.
ROBERT WILSON, Oversman, Arniston Colliery, Gorebridge.
ANDREW WILSON, Mining Engineer, 123 St. Vincent Street, Glasgow.
JOHN M'KAY, Manager, Climpy Colliery, Wilsontown.
JAMES A. CLARK, Manager, Ayr Colliery, Ayr.
WILLIAM ANDREW, Manager, Lassodie Colliery, Dunfermline.
ROBERT ANDREW, Oversman, Lassodie Colliery, Dunfermline.
ARCHIBALD M'KILLOP, Manager, Muiravonside Colliery, Linlithgow.
WILLIAM KIRKWOOD, Coalmaster, Larkhall.
ALEXANDER ROSS, Manager, Bog and Farm Collieries, Hamilton.

Other nine gentlemen were then nominated as Ordinary Members, and will be balloted for at the first meeting.

The SECRETARY then read replies from several similar Institutes, agreeing to exchange Transactions.

The PRESIDENT then intimated to the meeting that Messrs Robert Addie & Sons had invited the members of the Institute to visit Benhar Colliery on the 5th June, 1880, to inspect Messrs Beaumont & Bicknell's boring machine at work driving a stone

mine in one of their pits. He also explained that the arrangements were not completed yet, but that notice would be given by circular to all the Members.

It was proposed and seconded that the July meeting be held in Edinburgh. This was agreed to.

The PRESIDENT then addressed the meeting as follows :— My first duty is to thank you for the honour you have done me in installing me again as your President. It has always appeared to me that a change of President in Institutions such as this is attended with many advantages. New blood brings with it new ideas ; new systems, new arrangements, and new improvements— many of which are desirable, and all more or less beneficial. On this matter, however, at the present time, it is needless to descant, as you have decided the question, and the best must be made of it. I ask you, therefore, to accept of my best thanks.

At the commencement of the third year of this Institute's existence, it may be well to hark back and note the progress which has been made. I propose, then, very shortly, to do this ; thereafter, to add some hints for the future ; and then to offer a few suggestions as to subjects to be treated.

It is only two years since a few gentlemen—some of whom are now present—feeling that an Institute of this kind was much wanted, agreed that they would make an attempt to establish it. Mr Gilbert Burns Begg, Mining Engineer, was the first President --the rules of the Institute were on a card the size of a post-card, and its membership, I believe, was under sixty. It throve ; members increased, and justified them in seeking to enlarge its sphere of usefulness ; and now it stands out a full-blown, thriving institution. Our thanks are due to the founders, and to those who, at the cost of much time and labour, laid the foundation of what promises to be a leading Scientific Institution. I have said at the cost of much time and labour, for as yet we have not a single paid official ; and it will be admitted that the proceedings are published in as clear a form as those of any other society. I am able, impartially, to praise the exertions of the Council, because from circumstances I have been unable to attend any Council meetings, or indeed any meetings except the monthly general meetings ; but I can form an idea of the great amount of work

and classification necessary for the proper working of an institution of this kind.

It seems to me, however, that the Institute should aim at a much larger development than it has yet reached. If we only think of it—there are in Scotland about 70,000 people engaged in mining ; they raise 20 million tons of minerals, and I estimate that the capital employed is not less than ten million pounds. I regret to add that this is not done without the sacrifice of about 100 persons yearly, and severe personal injury to perhaps 500 others. These are the figures before us, gentlemen, and the problem we have to solve is how we should raise these minerals with the greatest comfort and economy, and, above all, with the least loss of life and human suffering. With these great questions at stake, it is the object of the members of such institutions as this to ascertain by careful enquiry amongst themselves, by comparing the efforts of others in other districts, and by all other means to ascertain our position in the race of improvement. Depend upon it, we have a long way to travel, and there is much hard and honest labour to be performed by one and all of us before we need to halt. There is no halting. It is the fate of all such institutions that, to keep pace with the times, they must be constantly moving forward—branching out into new work, and filling in the various details of an unfinished plan—keeping ourselves a-breast of the age we live in—and thus making the Institute worthy of the high position it is entitled to take up

It is cheering to know that the increasing numbers of members and prosperity of the Institute, have made it necessary to enlarge the rules and the sphere of its usefulness. There is not much in a name, perhaps ; but the Mining Institute of Scotland more truly represents the aims of the mining interests of Scotland than the former name.

I understand it is in contemplation to have meetings in various mining localities—such as, for example, Edinburgh, Kilmarnock, and Dunfermline. In each of these places there are mines and objects useful for the members of the Society to know ; and the members residing there, who may have some difficulty in attending our regular monthy meetings, will have an opportunity of benefitting the Institution by showing objects worthy of notice.

I look forward to these meetings with great pleasure, and believe they will be productive of much good, both to the Institute and to its individual members.

It seems to me that we should aim at a large increase of membership, for two purposes. First, for the sinews of war; and, in the next place, for increasing the area from which we can draw our information, and for the proper dissemination of it. It is only by a large and wide-spread membership that we can get for ourselves, and give to others, the full value which such an Institute as this can afford. To obtain these desirable ends, we have first to show ourselves worthy of support, and then endeavour to get it. I think most of people who look over our last years' Transactions, will be satisfied with the manner in which the various subjects have been treated, and will admit that the Institute has already done much good; and I am sure the members, and those who have read the proceedings, will admit that they have derived benefit from them, and especially those who have been present and joined in and listened to the discussions. We have, then, I say, fair grounds for bringing the claims of the Institute to the notice of the three or four hundred mining companies in Scotland, and to ask them for a greater amount of support, so that it may be made still more worthy of the country. It is especially the mine-owners, and the owners of mineral property, who will benefit by our success, and they will, I doubt not, respond liberally to any appeal we may make. I am not one of those who think that it is always for the good of an Institute of this kind that they should be helped from outside funds. I had rather see a working membership able to keep "day and way" by their own exertions than having great funds. We have done this hitherto. We have paid our way, and, except thanks to those who have contributed papers, "we owe not any man." But I think, in our present state, we might very usefully employ some more funds than we can now boast of. For example, we require funds for a museum, for a library, and for a reading-room, into which any of our members can at any time enter and examine any of the papers and periodicals, which are accumulating in our hands, or the books which we ought to have, and also where members and the Council can

meet and confer with each other on the business of the Institute. In order to manage this we must have funds. And, as I have said, we have a fair claim upon the mine-owners, and upon the owners of minerals, who greatly profit by our deliberations. I believe we have only to lay a fair scheme before them in order to raise the few hundred pounds which are necessary for the purpose. I specially draw the attention of the members and Council to this suggestion, and invite criticism upon it. If every mine-owner would give a donation of £10 for every 100,000 tons of minerals he raised for one year, and every landlord £10 for every £1000 he gets of mineral rent for one year, we would raise not less than £8000.

Should these remarks fall upon the ear or be seen by any of our coal or iron kings, I hope it will induce him to send a cheque to the Secretary, either for the whole sum or any part of it, and its receipt will be duly acknowledged. I am sure it will be as good a memorial as building churches.

I am glad to see in the new rules that provision is made for life members. Parties who do not choose to be troubled with annual payments may, by one payment, receive at all times the papers of the Society. I trust that many coal-owners, who cannot attend themselves, will take this means of adding to our exchequer.

It appears to me that any of the subjects which have been treated by gentlemen in former papers may with great propriety be further elucidated.

If there is one thing more than another which should be studied just now in coal mining, it is the substitution of machinery or horses for manual labour. There always will be, I suppose, hewers of wood and drawers of water; but it is desirable that they should be replaced by machinery wherever that is possible, and that their lot should be made as comfortable as possible. Everyone now-a-days sees the folly of drawing on long roads by men or boys, instead of concentrating the work to one point and putting in horses or machinery. In like manner, the bailing of water by men or boys has been less practised since it was found practicable to use small engines. I believe on these two points, of drawing coals on level roads and from deep workings, there is much room for improvement. Upon all

these points, the Institute requires many papers; indeed every member who has experience should communicate it. I would here remark that it is, I think, a great mistake to suppose that because one member has taken up a particular subject, and read a paper upon it, that the subject is exhausted and should not be touched upon again. To say so would be like saying that no more than one painting shall be made of one subject, We want the subject viewed from all standpoints, for no doubt as it comes up again some new points will present themselves, and be discussed for our benefit.

I suggest then that we might with advantage have papers by members on the various modes of haulage in use in our mining districts. I do not think our published Transactions contain any papers upon this subject; but whether or not it is a subject which should be again and again up before us. The length of time which rope haulage has been in use will enable economy in many districts to be fully ascertained.

I know there were some papers on rope haulage read, and good, practical papers they were; but it was before the Society's Transactions were published, and they are not available for our information. I suggest that this subject be brought again before us by some of our members. Lately I heard of an arrangement by which an engine placed at the surface drives a rope as a belt at a very high velocity, to convey power to the bottom of the shaft or where the haulage machinery is planted. It is said that 90 per cent. of the power of the engine is utilized. If this be established, it is probably more economical than taking steam for long distances, or than the use of compressed air. The subject of self-acting inclined planes has not had our attention. There are many arrangements which ought to be more familiar to us, and I think some of the members might usefully furnish us with a detailed account and drawings of the best of the various modes of self-acting inclined planes, and especially of the best temporary inclines which exist in the district. There are many rude devices for conveying coals down steep seams for short distances, from the "slype" upwards, that it would form an instructive paper. There is a system of "cut chains" peculiar to Fife, for I have seen it nowhere else, by which the tubs are

worked from several levels on the same incline, and which works very well. I should like much to see a good paper on "cut chain" inclines. While on this subject, I may suggest the propriety of this Institute enquiring about the gas engine, which is in use for power for printing-presses, driving agricultural machines, and other light work; there are many isolated situations where water has to be pumped or material raised from the dip, where they might be usefully employed. The application of hydraulic machinery might be considered. Only last week I saw a hydraulic engine, where, by a particular arrangement, the stroke of the crank could be made longer or shorter according to the load, and so the water was economised. It is clear that machinery must be largely adopted if we are to economise in the moving of coals from the face to the bottom of the shaft.

Associated with the haulage is the state of the permanent way —the kind of rail to be used, the width of gauge, and the reason for the preference. I do not think we have had any papers on this subject yet. Some time ago I saw at Whitehill Colliery various main roads ballasted like a railway, and with a sewage pipe laid for carrying off the water. I never saw better roads. The kind of tub to be used is another point. Whether we have hit upon the correct form of tub yet or not is an open question. It is clear that the old-fashioned tub is not held to be quite satisfactory, and so it happens that in the new winnings which have been started in this neighbourhood during the last five or six years, we have had almost every man trying his hand at some new form of tub— some of iron and some of wood, some with axle boxes outside like a railway truck, and some the ordinary way, and also with all gauges, from 18 inches to 3 feet, and holding quantities from 8 cwt. to 25 cwt. I think it is likely good papers might be got upon these subjects.

The employment of machinery for driving drifts in stone or coal is another subject which it would be well for the members to know more about. Some time ago I mentioned that at our doors —at Mr Addie's, Benhar—a stone mine was being driven by means of drills worked by machinery and blasted by dynamite. Mr Addie has been kind enough to send the Institute an invitation to see the machine at work, and I trust that many of you will be

able to take advantage of it. You have given permission to your Council to send a deputation to report to you, and I trust they will be able to satisfy you in this matter. It is not more than twenty years, I think, since the rock drill was beyond the stage of experiment. The Mount Cenis tunnel, which joined the railways of France with Italy, was the first long tunnel on which they were successfully employed, and it is only a few weeks since the St. Gothard Tunnel was put through by the same means. Mount Cenis Tunnel was 7½ miles long, the St. Gothard nearly 10 miles; but so great was the improvement in the machinery and arrangement that the latter only took 7½ years against the other's 13 years. The mean rate of advance in the St. Gothard Tunnel was 177 yards per month. Now, if we have the means of driving drifts at the rate of 8 or 10 yards a day, you can easily see what extraordinary facilities are afforded for opening up works such as were never dreamed of twenty years ago.

Akin to the application of machinery to driving stone drifts is the application of machinery to sinking shafts. I daresay it has often struck many of us as an extraordinary waste of power the having heavy machinery pumping water out of shafts while sinking —solely that the men might get working in the bottom; and that it would be a desirable thing if a pit of 12 or 15 feet diameter could be bored out in the same way as a bore is put down, while the water remains in it. Well, this has been practised for some years in France, and pits have recently been sunk in this country by the Chaudron system, as it is called. I have seen one of these pits at Whitburn, a place about 15 miles from Newcastle, and there it was a complete success. The problem which the Company had to solve was how to sink through the magnesian limestone with a feeder of, I think, 5000 gallons of water, at about 60 fathoms from the surface. The shaft, 16 feet diameter, was commenced in the usual way with pumping machinery, but the attempt failed after an expenditure of many thousands of pounds, and thence this French system was tried, and they succeeded in sinking through the water beds and afterwards in tubbing back the water so that the remainder of the pit was sunk dry. Well, this Chaudron system is neither more nor less than a big chisel 16 feet across, or rather a crosshead with chisels fitted upon it, and

the whole arrangement is simply a common boring apparatus on a large scale. The system of tubbing is very ingenious and very complete; the whole thing strikes one as amazingly simple, and the wonder is that it was never done before. There is a very complete description of the process in some of the scientific papers, but I will not take up your time with it. I think some of your members have seen it, and I trust that a paper upon it may be forthcoming.

The mention of tubbing reminds me how seldom this very useful expedient is adopted in this country. Very great improvements and modifications of it are now practised, and a very simple lining or walling of concrete is now found suitable for stopping back feeders of water and forcing it some feet above its level, until it either reaches a higher level to be pumped there, or else, as not unfrequently happens in this selfish world, it gets away to some less scientific neighbour, who, not without a grudge, has to be content and lift it. I think many of our members may contribute information to us on this subject.

Akin to rock and tunnel driving machinery, is the subject of coal cutting machinery, upon which we are to have a discussion to-night, and upon which I trust there will yet be many more papers; for while Mr Begg's is an admirable paper, it by no means exhausts the subject. His paper simply proposes one application of the machine, but I trust we will yet strike out a new path, and on new principles with wider aims. The coal cutting machine, as now for the most part arranged, is simply a holing machine. It is simply following out the action of the miner in underholing the coal so that it may fall and there be broken or break itself into lumps suitable for filling into the tubs. The coal cutting machine is thus dispensing with fewer men in high seams than in low seams, where the holing forms a greater proportion of the work. It has not been found of great use in thick seams. It strikes me that we might try some other principle instead of following the miners' movement so closely—something like saws for cutting the coal into blocks without holing in the way that is now done. Moreover, an application of this kind might be arranged for brushing roads instead of blasting it down as is now done. The successful application of

a machine to supersede manual labour is often of slow growth, and it has to undergo many expensive and disheartening trials and alterations before it reaches success, and I know of none more so than the coal cutting machine. No doubt success will come, but I question if we have yet hit upon the principle. I point out what occurs as an apt illustration—the reaping machine. Doubtless many failures occurred in attempting to make an artificial hook or scythe, but when once the idea occurred of using the scissor movement all became plain sailing. In like manner, I have no doubt, if we once hit on the right idea of how best to apply machinery to extract the coal, there would be a great rush for machines as there has been for other marked improvements in mining.

On the subject of working coal we have had some excellent papers from our members, but we may, with advantage, have the matter raised again and again. Moreover, our society is continually increasing in members, and it is desirable that we should have more papers upon this subject.

From careful statistics, which I made for years, there does not appear to be, in this district at least, any difference in point of safety between long-wall and stoop-and-room, and I think the whole question is one of economy.

It is evident that, in a seam where the roof must be taken down for height of road, that there is greater inducement to work by the long-wall method than where the seam is high enough without brushing for haulage purposes, and the roof is only taken down for building the sides of the roads. In the latter case, there is certainly all the stone-work extra, and, as I think upon the whole, probably as much coal will be got and in as good condition the one way as the other, the whole question of economy, comfort, and safety, as regards ventilation, will be readily determined.

I should like especially to call attention to Mr Robson's paper on the routine of a North of England Colliery, and especially to elicit more information and opinions on the mode of supporting the roof there set forth, and upon any improvement upon it.

I feel certain that the time has come when a change might advantageously be made upon our system of supporting the roof,

and the question of the economical supporting of the roof is one to which the view of the members should be steadily directed. The question might take this direction—Whether a regular system of putting up props at certain intervals to be drawn out when persons no longer work under the place likely to be affected by their removal, or whether we shall only require props to be put up where, in the opinion of experienced men, they are necessary.

Any one who has observed the working out of stoops during the last fifteen years must be struck with the improved economy and safety which has been obtained, and mainly owing to the great increase in the number of props set up, and to the better discipline and system adopted.

Before the time I speak of, in Scotland at least, there was little attempt at discipline in taking out pillars—they were taken out in a hurry, and were in many cases entirely lost. At present, however, very much owing to the free use of wood, the fatal accidents from falls of roof are very few indeed in comparison to what they were, and the non-fatal accidents from falls are fewer where stoops are worked on the improved plan.

The mode of putting up props and gears is one which might be studied with advantage, and it appears to me is susceptible of improvement, particularly gears or bars, and I trust some of our members will study the question and give us their experience. The French and Belgian engineers have paid great attention to this. Could iron not be used to support the roof in permanent roads? Could buckle-plates not be used?

This encourages me to hope that some of our members will take up the economical and effective propping or supporting the roof where men require to work.

In the same category is the supporting of the coal by sprags and gibs, which is such a fruitful source of accident, and I am glad to say that in one colliery at least, the Special Rules stipulate that there shall be sprags at least every six feet.

The subject of Winding Machinery has been very well treated by one of our members, and I am sure we were all delighted with the clear manner in which he illustrated his remarks. The discussion on this paper, was, I am certain, very useful; but we

need more papers upon the subject, and on the most economical machinery. If some of our mechanical members would think over this matter, and give us papers on the best and most economical form of winding engine, the best distance from the shaft, the most economical form of boiler and steam pressure, it could not fail to be of interest and use. If we compare a locomotive engine with an ordinary winding engine, we cannot but be struck with the great difference there is in bulk for power.

It seems to me, also, that we should have higher pressures. It is difficult to see why a locomotive should work at 100 lbs. per square inch, when very few of our engines reach 40 lbs. Of course the boilers would require to be proportionately strong, but there does not seem to be anything in point of safety which would justify such a difference.

Engines for pumping water are very suitable subjects to which our attention may be directed. Forty or fifty years ago, the common pumping engine was the atmospheric engine with walking beam over the shaft. Shortly afterwards, bell-cranks were adopted, and their great handiness for short and light lifts led to their almost universal adoption in the West country at all events; but now since the shafts have got to be deeper, and the quantity of water more difficult to raise, the direct or beam engine is coming more into vogue.

The general substitution of plungers, and of lifts of 50 or even 100 fathoms in depth, is simplifying these arrangements. Papers on these subjects are much wanted.

Generally, the whole surface arrangements of a colliery require careful studying, and it is to be hoped it will be taken up in detail; the best arrangement of rails and sidings, the best forms of screens, and the best arrangements for cleaning coal. I notice at Earnock Colliery a departure from the common practice, where there are a number of screens for the sake of slow passage of the coal down the screens to admit of better cleaning. We have also in our neighbourhood various arrangements for cleaning coals—travelling tables, revolvers, and such like—all of which should come before us.

On the Continent, this matter is much better gone into, and at the last Paris Exhibition there were many models of

screening arrangements, showing the great attention paid to cleaning coal in the French and Belgian collieries.

Coal washing machinery is another subject upon which we require papers; also coking arrangements. On this head, I may mention that too little attention has been paid to the analysis of coal, and perhaps some of our chemical members might give us information on that point.

Under this head, I may note a very unusual accident brought to my notice, the fracture of two pulley axles. This very seldom occurs, and is worthy of our notice.

While remarking upon this, I might note that information as to the best forms of cages and guides might be useful. In the more recent fittings cages are made of steel for lightness. It is also customary to dispense with stops at top and bottom of the shafts and the cage never lands, and so the shock, particularly when there are two and three decked cages, is thereby avoided. It seems that with a careful engineman there is little time lost, less perhaps than the operation of lifting and setting as now practised.

In England, more particularly in Midland districts and in South Wales, wire rope slides are much used, and, I am told, are getting more into use. They are suspended from the pithead frame, and are kept taut by weights attached to them in the sump. They offer many advantages in the shape of a clear pit, and they take up little room. A very good example of these wire guides is to be seen at Fence Pit, Lesmahagow, but that is not the newest arrangement, for there are four guides to each cage; whereas in the more recent development there are only two guides on one side of the cage, the inner sides of each cage merely rubbing upon the two ropes which separate them.

At Earnock Pit, in this vicinity, the slides are of railway bars, and slippers on one side is all that keeps the cage in position.

There may be something in desire for change, but it is quite likely that both plans may be an improvement upon the old-fashioned wooden slides.

While on this subject I may be permitted to notice the ingenious signals of our member, Mr Smith. As stated at the time, the arrangement does not appear to be all that is to be desired, but it is to be hoped that he will be induced to persevere with it.

I should like to see some of our members giving us some papers upon the stratigraphy of the districts, tracing the thickening and thinning of the various seams and any other particulars of them. It has often occurred to me that the remarkable thinning of strata between the pyotshaw and main coal, and between the splint and the ell coal, merits more attention than has been given to it. The area of country containing blackband ironstone and many other facts would be useful to know. It has always seemed to me a curious thing that as a rule our mining men do not know so much of geology as might be expected.

In no department of Scotch Mining has there been so much advance as in the quantities of air sent into pits. Twenty years ago I published a small work on ventilation, in which I stated that, with the exception of Nitshill Colliery, 10,000 cubic feet of air per minute was sufficient for any pit in Scotland. That statement was never challenged, it could not be challenged, for it was true at the time ; but how insignificant is its quantity compared with what is now about some of the pits in the district will be seen by the following :—

1. Auchenraith (Merry and Cunninghame). In this colliery 193,000 cubic feet of air per minute is supplied for the 255 persons employed underground. The air is distributed over the ell, pyotshaw, main, and splint seams, each seam having separate intake and return airways. There are 11 distinct currents travelling an average distance of 1,550 yards, through airways having an average area of 52 feet. There are two shafts, both of which are used for winding. One shaft is a downcast, and the other an upcast, and each has an area of 161 square feet. The ventilation is caused by a fan, 30 feet diameter, 10 feet wide, making 50 revolutions per minute, the water gauge being 1.5 inches.

2. Blantyre (Wm. Dixon, Limited). This colliery consists of five shafts, and has two arrangements for ventilation. First—Nos. 1, 2, and 3 are downcast shafts, and No. 5 their upcast. The quantity of fresh air amounts to over 145,000 cubic feet per minute, which ventilates the ell and splint seams, where 481 persons are employed daily. In these pits there are ten separate currents of an average length of 2107 yards, the longest distance

travelled by one current being 3966 yards. The average sectional area of airways is 41 feet. This ventilation is produced by a group of 3 furnaces, each 8ft. × 4ft., placed close to the bottom of No. 5, the upcast shaft, which is 10ft. diameter; water gauge at furnaces 1 inch. The second arrangement is for the ventilation of No. 4 pit, where 136 persons are employed in the splint coal. The shaft is divided by a midwall, the downcast portion being 128 feet in area, and the up-cast 64 feet. There are two 14ft. fans, one of which is usually in operation at a time, and over 34,000 cubic feet per minute passes through the workings. There are four separate splits of an average length of 1325 yards, the area of the airways being 40 feet. There is thus a total of 180,000 cubic feet per minute for the 617 persons employed underground in this colliery.

3. Newbattle (Marquis of Lothian). The aggregate quantity of air here is 154,640 cubic feet per minute, and the persons employed number 487. In Dickson's pit, which is a downcast, there are four currents, each travelling an average distance of 2,480 yards, area of airways 39 feet, and the total quantity of air is 55,700 cubic feet per minute for 222 persons. In the engine pit also a downcast, 45,200 cubic feet per minute is divided into three currents, average length of currents 1810 yards; airways, 37 feet area; persons employed, 152. There is a separate upcast for these two pits, 10 feet in diameter, and the ventilation is caused by a fan. 30ft. × 10ft., going 42 revolutions per minute. The ventilation of Bryan's pit, where 107 persons are at work, is produced by a furnace, and 35,000 cubic feet per minute passes through the workings, without any distinct splitting, a distance of 4566 yards, the airways being 33 feet in area. In the Shaws pit only six men are working, and a current of 18,750 cubic feet per minute, which travels 1166 yards, ventilates the workings. These two pits have each separate up-casts.

4. Fence (Nitshill and Lesmahagow Coal Co.) The total quantity of air is 91,340 cubic feet per minute for 312 persons. 71,740 cubic feet supplies the 193 persons in the Fence Pits, which are both downcasts, and the air is divided into six currents, which travel on an average 2292 yards, the longest current being 3680, and the shortest 810 yards. The sectional area of

the principal airways is 50ft. The Braidholm pit employs 119 persons, and 19,600 cubic feet per minute passes down this shaft and is divided into four currents which travel an average distance of 2627 yards, the airways being 27 feet in area. The ventilation is produced by a fan 20ft. diameter and 8ft. wide, placed at a separate up-cast shaft 10ft. in diameter. The speed of fan is 60 revolutions per minute.

5. Bothwell Park (William Baird & Co.). A total of 90,000 cubic feet per minute ventilates the workings in the two pits, where 305 persons are employed underground daily. There are four currents, each of which travels an average distance of 1280 yards, the average area of airways being 40ft. One pit is a downcast and the other an upcast; at the top of the latter there is a fan 25ft. diameter and 8ft. broad, going 50 revolutions per minute. Water gauge $3\frac{1}{16}$ inch.

6. Cadzow (Cadzow Coal Co., Limited). There are three shafts, two of which are winding and downcasts, and the other entirely an upcast. 81,900 cubic feet per minute ventilates the ell and main coal seams, where 215 and 20 persons are employed respectively. In the ell coal the air, 67,000 cubic feet, is divided into three currents, each passing an average distance of 2730 yards through airways 55 feet in area. In the main coal, 14,900 cubic feet per minute is divided into two currents, each of which travels 500 yards; area of airways, 42ft. A fan, 40ft. diameter and 12ft. broad, is the ventilating power. It makes 30 revolutions per minute; water gauge at the fan, $1\frac{1}{4}$ inch.

We have had good papers and much discussion about fans and ventilation, but we have by no means exhausted the subject, and I hope some of the members will still further explain its action. I may be wrong, but I think that more information has been got by members on fans than on any other subject, and I believe that papers on them would have a good discussion. I think the members are now clearly in possession of the idea that the quantity of air which a fan delivers is very seldom that due to the capacity of the fan. It depends upon the freedom with which the air gets into the ear of the fan, and without capacious airways it is impossible to get the most useful effect. Also the fallaciousness of expecting that one fan at one pit, with a certain number of strokes

will discharge as much as another at another pit with the same number of strokes, unless the size, number, and length of air-ways be also the same. It would be wrong in me not to mention the ingenious instrument of Professor Forbes for detecting fire-damp. I need not add one word more, however, to what was said by the members at the time. I am glad we are promised a paper on another similar instrument by a young gentleman who is a member of our Institute. The studies of these gentlemen are all useful to us, at least they tend in that direction; and as they must evidently be persevered in purely from philanthropic motives, for no man is likely ever to make profit by them, they are worthy of our best thanks.

There are now 108 ventilating fans at work in the Eastern district of Scotland. These fans are utilizing from 30 to 50 per cent. of the power of the engines, and in all cases they have increased the ventilation. The introduction of fans has also led to a better knowledge of the principles of ventilation, to the advantage to be gained by splitting the air currents and increasing the area of airways, thereby reducing friction by diminishing the velocity and length of currents.

On the subject of lighting of mines let us hope there is a chance that at no distant period we may have some cheap and simple mode of electric light, or of some luminous substance which will, in a measure, supersede lamps, and such an improvement is much to be desired.

The safety of the Davy lamp has been discussed in kindred institutions, and many experiments have been made and papers written upon it. I think papers on this subject might be usefully read, for it would disseminate information which we much need.

I may remark that the majority of the experiments have been made to test at what speed of explosive air-current a Davy lamp will pass the flame through the gauze, for it is beyond dispute that this is done; indeed, for that part no lamp can properly be called a safety lamp under all conditions.

I do not altogether approve of the tests applied, for there are few conditions where, at all events, the current at that speed in the workings is explosive. I think that a lamp which will not resist an explosive current, say of 8 or 10 feet a second, may often be usefully employed.

I have thus touched upon some points which seem to me to be necessary for the continued success of the Institute, and I trust the members will contribute papers liberally. They need not necessarily be long, nor occupy the night, but they should be well illustrated. I particularly call upon the younger members to contribute. They may take my word for it, that the very work of writing a paper brings with it an amount of knowledge, of which they can have no idea till they try. I hope, therefore, that every one will continue to do what they can, and that this prosperous Institute may still further prosper and be the means of doing much good.

Owing to the unavoidable absence of Mr Begg the discussion on his paper was adjourned.

A vote of thanks to the President brought the meeting to a close.

MINING INSTITUTE OF SCOTLAND.

VISIT TO THE WORKS OF MESSRS ROBERT ADDIE & SONS, BENHAR,

5TH JUNE, 1880.

By the kind invitation of Messrs Robert Addie & Sons, about forty of the members met at Benhar on Saturday, 5th June, and inspected the boring apparatus of Messrs Beaumont & Bicknell, which is at present being employed in driving a stone mine in No. 1 pit. They were received by Mr James Morton, general manager, who accompanied them underground. Mr Bicknell, one of the patentees, was also present.

The mine in question is 6ft. high and 10ft. wide, and dips at the rate of 1 in 6. It commences at a point on the main level about 100 yards from the shaft, and is now about 200 yards in; its ultimate length will be about 360 yards, where it is expected to cut the slatey-band ironstone on the dip side of a fault. The boring machines are driven by compressed air at a pressure of 60 lbs. to the square inch. The steam engine and air-compressors are situated on the surface at No. 1 pit, the air passing into a receiver, from which it is conveyed down the shaft and into the mine in wrought iron pipes, 4 inches diameter. There are four boring machines (Fig. 1) fixed on a suitable carriage fitted with wheels. The members had an opportunity of witnessing the operation of boring the holes, which were put in at various angles and positions, and also of examining the apparatus while at rest. The strata at the face of the mine was chiefly fire-clay. With one machine at work a hole was bored to a depth of 4ft. 9in. in five minutes; with two machines at work, one hole 4ft. 11in. was finished in $7\frac{1}{2}$ minutes, and the second hole, 5ft. 3in. in $9\frac{1}{4}$ minutes. The operation of boring and changing the drills, of which there were two of different lengths required for each hole,

was very expeditiously performed. While boring, the holes are cleared of debris and the drills kept cool by a jet of water directed into each hole, the water being conveyed from a point in the shaft giving over 100ft. of head. This arrangement appeared to act satisfactorily, although the material being bored was least favourable for the cleaning of the holes, from being soft and tending to clog in the holes. The water so used has, of course, to be got rid of, which is a disadvantage in a dip mine. It is pumped back, along with the water met with in the mine, by a small pump, also driven by compressed air. The number of holes put in, their depth, and also to some extent the order in which the holes are fixed, depend on the nature of the strata, but in average ground about 20 holes are bored before blasting commences. Dynamite is the only explosive used. Three men are required to attend the machine while boring, and also during blasting operations. The general procedure will be gathered from the following:—Machine lowered into face by crane and four men, fixed, and pipes connected, occupies 30 minutes; boring commences, and occupies about 2½ hours; machine unfixed, and hauled up 30 yards, blasting operations commence, the shots being fired as the circumstances warrant; time occupied, 2½ hours; interval of 30 minutes for fumes to be carried away by the ventilation; commence to clear away the debris, which is filled into tubs and drawn up the mine by a small engine erected at the top of the mine. Seven men are employed filling, and the time required is about 8 hours; ready for machine; the whole round of operations occupies about 14 hours, and the advance equals, on an average, 4ft. 6in.

The mechanism of the boring machine was explained by Mr Bicknell.

DESCRIPTION OF THE BORING MACHINE.

Mr BICKNELL—I have been told that we are very short of time, but I shall try to briefly explain to you our rock boring machine, and you must therefore forgive me if I very hurriedly run through the different movements of the drill. The drill has been invented about four years; during that time it has been at work in Cornwall, Wales, Germany, Yorkshire, and now in Scot-

land. The greatest speed ever attained by this drill has been 37½ yards in a 10′ 6″ × 8′ 0″ heading, in one week, *i.e.* from ten o'clock on Sunday night to six o'clock on the following Sunday morning. This is rather infringing on Sunday you will think ; but it is not our rule to work before twelve o'clock on Sunday night, or after that time on the Saturday evening. The number of men were four for the boring, eight for the blasting shift. The position and number of holes depends entirely on the nature of the ground in which we are boring. As a rule, an advance of one yard is obtained in such ground as was seen to-day ; about 19 to 20, and sometimes 24 holes are necessary. It is most important that at all times the holes should be put in of even depths ; to obtain an advance of 3ft., the holes should not be less than 3′ 5″ or 6″. Dynamite, as a rule, we use for blasting, on account of the holes being wet from our using water to clear out the debris made by the drills in the hole. Dynamite, therefore, that will explode in water, is found more beneficial, being so much more powerful than powder, gives a greater speed of driving. These drills, or drills similar, are also very useful in sinking pits. You are aware of what they are like after being put together ; this is a small photograph of one *(Plate I.)*, and I think you will agree with me that it is of neat and compact design. Its weight is about 3 cwts., and when in good working order with a pressure of 60 lbs. of air, will strike a blow of 5 cwt., the average number of blows per minute being 300 to 350.

The piston is a double piston—the reason for this being that it works its own valve ; the valve is a flying valve—but I am afraid I have not time to go into it—which is the secret of the drill and complicated. You will notice that there are four ports leading into the cylinder; the two centre ones are those that admit the air to the valve and reverse it as the piston travels to and fro.

The twist is obtained by means of two spiral grooves, into which these (showing) keep fit. Besides the two spiral, there are two straight grooves which are arranged by means of ratchet wheels and pawls to make the piston twist in the backward stroke and not in the forward. This as well as the automatic feed motion would, to make you really understand, take longer than on this occasion you can spare me.

Brass and indiarubber cushions are placed in the front and back covers to prevent the possibility of them breaking should the piston strike them. The mode of fastening the drills on to the camel I have no doubt you noticed when underground. It is very complete, giving power to the operator to put his drill in any position he may wish, and therefore place a hole whereon, and at whatever angle he may desire on the face he is working against.

The camel or carriage on which these drills are carried is of a somewhat new design. It has a cast-iron centre column with rings round it to enable a cog wheel to work in for moving the arms, carrying the drills upwards and downwards. It has also a convenient arrangement attached on which the regulating taps for both air and water are fixed. *(Plate II.)*

Perhaps it will be interesting to you to know that the borer consumes about 20 feet of air a minute, when giving 300 strokes at 50lbs.

In a new drill we have designed, we have got a new twist by boring a hole in the middle of the piston and regularly twisting it round by means of a ratchet wheel fixed there (shewing), worked by a lever and pawl. I am very sorry that the train arrangements compel me now to close by remarks, which, I fear, being so hurried, have been anything but explicit.

I hope, however, as I said before, if we are successful in getting the Clyde contract, you, gentlemen, will come and see me again, and I will try and explain, in a great deal more detail, our boring machinery. I must thank you all for listening so attentively to me, and I hope to see you again.

Mr GILCHRIST—Would Mr Bicknell tell us the price of the boring machine we have seen at work?

Mr BICKNELL—The 4″ drills, such as you saw, are £85; the price of the camel is £135; of the engine you saw working the compressed air, £75; the compressors you saw, £175; and the portable engine, £150.

Mr GILCHRIST—I understand that the engines at present compressing air are barely sufficient to keep two of the drills working simultaneously. Would Mr Bicknell give us the price of the plant necessary to compress sufficient air to work all the four drills together?

Mr BICKNELL—The price of an engine sufficient to drive four drills, such as you saw, would be £600 complete, or if you liked to have a semi-portable engine, after the Robey style, capable of driving four drills, the price would be £950, engine and boiler complete.

I shall be glad, if any gentlemen has any driving or sinking to do, to give an estimate for the work, and come myself, or send my agent, and wherever it is, and at whatever time, I shall be glad to give them a price for any work, or the price for the machinery if they would prefer to buy it.

I will leave these photographs with the secretary. I think, perhaps, they will be interesting to you. There are smaller drills which are cheaper, but, for driving stone levels, I would advise that nothing less than two drills should be used, as nothing less than 4″ drills are beneficial. Three inch are very well in their way, but only 4″ ones are, as I have said, really beneficial.

On the motion of Mr Gilchrist, a hearty vote of thanks was accorded to Mr Bicknell for his description.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING, 17th JUNE, 1880,

IN THE

HALL OF THE INSTITUTE, HAMILTON.

G. B. BEGG, Esq., and afterwards J. T. ROBSON, Esq., in the Chair.

THE Minutes of last General and Council Meetings were read and approved of.

The following gentlemen, who were nominated at the last General Meeting, were duly elected Members of the Institute, viz.—

ORDINARY MEMBERS.

MATTHEW BAIRD, Colliery Furnisher, Robertson Street, Glasgow.
JAMES SMITH, Coalmaster, Saracen Colliery, Possil.
JAMES ORMISTON, General Manager, Castlehill Iron Works, Carluke.
ROBERT F. MOORE, Civil and Mining Engineer, Croft Villa, Rutherglen.
ANDREW HUNTER, Manager, Alloa Colliery, Alloa.
JAMES MAXWELL, Manager, Thrashbush Colliery, Airdrie.
WILLIAM GARDINER, Manager, 97 West Regent Street, Glasgow.
ABRAM THOMSON, Manager, Cornsilloch Colliery, Larkhall.
HUGH PATERSON, Manager, Braidhurst Colliery, Motherwell.

Eleven other gentlemen were then nominated as Ordinary Members, and will be balloted for at the first meeting.

Mr ANDREW WILSON, Civil and Mining Engineer, 466 St. Vincent Street, Glasgow, then read the following Paper :—

THE DETECTION OF GASES IN MINES.

As this is a subject of great and increasing importance, as well as of considerable difficulty, I have ventured to bring before your notice a means of detecting gases, with which I have been making a few experiments, and which may possibly be new to some present. It would be superfluous for me to make any refer-

ence to the various means presently employed for detecting gases. The most useful and important invention for that purpose is the Davy Lamp, and we have every reason to believe that it will continue to hold its present position as the most reliable test we have.

The idea that occurred to me, and which I have put into a crude practical form for the purpose of illustrating the mode of action, consists of an ordinary unjust balance *(Plate III.)* made of brass or copper wire, the fulcrum of which is at one-third of its length. On the long end a perpendicular wire is hung. The top of the wire is constructed to grasp a ball filled with common air. A weight is attached to the lower end to keep the air-ball in position. On the short end of the beam a lead weight moves on a screw for the proper adjustment of the balance. The balance is connected with an electric bell.

When the air-ball is surrounded by gas lighter than common air it descends, when surrounded by gas heavier than common air it ascends, and when the temperature of the atmosphere surrounding the air-ball is increased to 120° it bursts and falls off the brass arm. The balance is thus lightened, and it ascends as when in the presence of choke-damp. Whether the action of the balance is ascending or descending a connection of the electric current is formed which causes the bell to ring. The action of the balance is based upon the fact that fire-damp is lighter than common air, with which the ball is filled, and that if held in equilibrium in common air, upon it being introduced into fire-damp, it would sink.

In any gas the pressure exerted, whether ascending or descending, would depend on the difference of the specific gravity of the gas from common air, and also on the area of the air-ball.

The downward pressure exerted on any air-ball of 50 cubic inches capacity, in a mixture containing one per cent. of fire-damp is ·07045 grains. From this you will perceive that the finest balance constructed will not act in a mixture containing one per cent of fire-damp. In a mixture containing two per cent of fire-damp the downward pressure is ·1409 grains, exactly double of what it is with one per cent., showing that the increase of pressure is directly proportional to the increase of fire-damp in the mixture.

Two per cent. of fire-damp may be detected with a balance similar to those used by chemists, which are constructed to weigh to one hundredth part of a grain.

The most explosive mixture—one of gas to seven of air—exerts a pressure of ·9863 grains on a 50 cubic inch air-ball, and as the quantity of air in the fire-damp is lessened the downward pressure increases.

Pure fire-damp without being mixed with air exerts a downward pressure of 7·045 grains on a 50 cubic inch air-ball. Choke-damp affects the air-ball in a similar manner to that of fire-damp, only the action is ascending instead of descending.

For the detection of minute quantities of fire-damp, a balloon filled with hydrogen gas might be substituted, without being attached to a balance. In that case there would be no friction.

Several experiments were made with this balance at two Collieries in the presence of several members of the Institute and others. In the first instance the place chosen was the ell coal waste; the gas given off was supposed to be choke-damp of the ordinary kind, but the instrument when introduced into the mixture acted in the same manner as in fire-damp.

The gas had no appearance of being fire-damp, a light was extinguished in it, and at a point where a quantity of air was circulating it had no appearance of being explosive; the flame of the lamp was not elongated, nor was it surrounded by a blue cap. We came to the conclusion that the mixture was fire-damp and carbonic oxide.

Choke-damp or carbonic acid gas is converted into carbonic oxide by the action of fire, such as occurs spontaneously in the ell coal waste.

At the second colliery, this instrument was tried in highly explosive fire damp, and it acted at once. The cavity where the fire-damp was allowed to accumulate was about three feet square, and one foot above the level of the roof. The air-ball was wholly covered with the gas, and, when placed in position, it sunk 1¼ inches.

In constructing this balance for the detection of gases the primary intention was to have an instrument situated in any available part of a mine to give immediate warning should a sudden

change occur in the pressure of the atmosphere. Because while the gases pent up in the waste or in any other reservoir are immediately liberated, the change of pressure is not so quickly registered by the barometer.

In a mixture of gases having the same specific gravity as common air, this instrument would not act, but it is not likely that such a mixture could become explosive. Whether this method I have described contains the germ of a practical solution of the difficulty of detecting small quantities of fire-damp, I am not in a position to determine as the experiments have been conducted in a primitive fashion; but should any of your members feel sufficiently interested in the matter to prosecute the enquiry further, I shall be glad to furnish what assistance I can. At all events, it will form a subject for discussion, whether any good result is to be looked for in the direction I have suggested.

DISCUSSION.

The CHAIRMAN—It is possible some of the Members may have some questions to put in regard to the paper, and, if so, I think it would meet every one's convenience if they were asked at once.

Mr HASTIE—What are the batteries made of?

Mr WILSON—The usual Leyden jars with water and zinc, just an ordinary battery.

Mr HASTIE—You will just put the zinc rods in the centre cells?

Mr WILSON—Yes.

Mr SCHUMAN—Do you intend to leave the walls round the air ball as now?

Mr WILSON—No, sir.

Mr SCHUMAN—The reason I put this question is because it occurs to me the coal gas you now apply to the bottom of the air-ball, through the India-rubber pipe, will, of necessity, press the ball upwards, more particularly where the dispersion of the gas is prevented by these walls. You now discharge or press your gas through an open orifice on to the ball, thus you bring a direct pressure to lift upwards, different to what would happen with marsh gas floating on an atmosphere depending on accidental

surroundings for its motion, when the outer walls of your instrument would come in contact with the gas. The gas will either assume an elongated shape and pass at the sides or over the air-ball, without touching, or with so little pressure that it will not raise it and cause the ringing—granted. You hold the full open front of the instrument to gas and cause a draft through the inside upwards, the instrument is that small you would have first to ascertain where the gases are floating and then confine them to pass through the instrument upwards to cause the bell to ring. With the carbonic acid gas you may have a better chance, its tendency being to descend. It may accidentally, when the instrument is suspended or placed within its area, press the ball downwards ; altogether, this is a beautiful laboratory instrument, the same as the Damposcope and a variety of lamps invented for the same purpose, but for practical application, I am afraid, unsuitable. I also have given consideration to the means for the detection of these dangerous gases, but after all, this alone is not the object to aim at. Simply to discover the gases will not do much good to the community. I think we may now assume that all mines have more or less of these dangerous inmates within them. What we have to study is to discover the means to destroy and make them harmless. This might be done by periodically scouring the mines with fresh air, or other means, and not to depend too much on the possible mutual absorption of the light and heavier gases, as I heard it mentioned at the lecture on the Damposcope.

Mr WILSON—With regard to the remark that this gentleman has made in connection with the cover, this box that I have placed on the top is simply for the present circumstances and not for the circumstances that arose before I came here. At the colliery where the experiments were made, there was no box attached ; the instrument was simply put in a position where it came in contact with gas, and when in that position it acted at once. I do not know really what position in the return air-course fire-damp and choke-damp would occupy. I do not think, if passed under a fall, the fire-damp would lodge in the space above the air current. If it did so it would be accumulated gradually and would be easily detected.

Mr ROBSON—I apprehend Mr Schuman did not mean that the choke-damp and fire-damp would act in this manner in the return air-courses; what I understood him to mean was that in quiet corners of the workings the gases would act in the way he indicated

Mr SCHUMAN—That is quite right.

The CHAIRMAN—Of course I did not mean that the discussion was to be formally taken to-night. My suggestion was more to specify the difficulties any of you might have, any doubts of the method of action, or want any little explanation from Mr Wilson. It will help to prepare us for the formal discussion which will take place next night. There is one thing I would like to ask Mr Wilson—has he ever examined the action of his instrument under the different temperatures that occur—I mean, how it acts under the ordinary range of the barometer? Suppose he got a permanent instrument of this kind put into a mine to give permanent indications, has he considered how a change in the barometer might affect the instrument, and if so, is not that a difficulty?

Mr WILSON—With regard to the temperature, I do not think that the action either ascending or descending will be affected so far as the temperature is concerned, but a change in the pressure of the atmosphere will affect it, though not to a great extent. The only effect I have seen an increase of temperature have, was simply to expand the ball so that it burst and fell out of its position, the instrument was thereby lightened and the beam ascending rang the bell. I have not seen it particularly affected by a change of the barometer, but I am perfectly certain it will be affected by it.

Mr DRINNAN—Is the ball of such a nature as to be incapable of stretching and increasing in size on the air being heated?

Mr WILSON—It increases in size till it goes beyond its capabilities at 120°. A ball might be constructed to burst at any temperature.

The CHAIRMAN—And necessarily the ball must be elastic?

Mr WILSON—Not necessarily. I think the ball might be made of tin.

Mr HOGG—If the ball was made with tin, which would not expand with the heated air, would it not sink whenever taken

into a heated atmosphere whether there was gas in that place or not. I can see that, if allowed to expand, changes of temperature would not affect the balance, but if the ball was made non-elastic I cannot see how it would balance properly.

Mr WILSON—I don't mean to supersede this ball with a tin one. I merely meant to say it would act as completely. If the temperature is different and if expansion is not equal, then there must be a descending, or ascending movement. In the case of an increase of temperature, the variation either up or down is overcome by the equal expansion of the air outside and inside of the airball.

Mr RONALDSON—Suppose you have a sudden expansion outside, something getting heated up, it might fall and ring the bell.

Mr WILSON—I fancy if the air is suddenly heated outside, it must be too sudden to be safe, and it might be beneficial that the ball should be rung.

Mr DRINNAN—In ordinary cases the mine would not be likely to be heated so as to make it fall sufficiently for to ring the bell.

The CHAIRMAN—Not certainly in ordinary circumstances. It would be something terrible if that happened.

Mr ROBSON—Might I ask if we could get further information as to the experiments Mr Wilson and other gentlemen made with this instrument. I think that it would be very desirable to know the position where the instrument was placed, and the amount of current and so on.

Mr WILSON—The first experiment was in the ell coal, at the further extremity of the air current. I was disappointed that the instrument did not indicate choke-damp, but on filling one of the balls with the gas, we found that it weighed lighter than common air, proving conclusively that it was not choke-damp of the ordinary kind. In the other instance, it was in a mine at a small fall, about a foot high, above the level of the roof. The air was cut off, and a quantity of fire-damp a foot thick allowed to accumulate; and we introduced the instrument several times, and with the effect mentioned—it sunk an inch and a quarter.

Mr ROBSON—Did you try it in a common place, where the instrument could be of use in a pit? Has it been tried in the

returns, or in the ordinary current of air ventilating a particular district, and, if so, what was the effect there?

Mr WILSON—No, sir.

Mr ROBSON—I cannot see the good of its being taken into a hole, making a place for the gas to lie. What you want is something to tell you if there is really a percentage of fire-damp in the air when you fail to detect it by ordinary means.

Mr WILSON—The great difficulty is to get a place where it is acknowledged there is a quantity of fire-damp in the return air courses. I question very much if it would be possible for me to get such a place at all.

Mr DUNDAS SIMPSON—If there was fire-damp in the air that is passing along the return, would the instrument detect the fire-damp to a small percentage that was conveyed along with the current?

Mr WILSON—If the difference of the specific gravity was above 2 per cent., or even 2 per cent., it will detect it if not neutralised by some heavier gas, and the specific gravity thereby increased.

Mr FAULDS—I would like to ask Mr Wilson how it would act in an air current where there is a quantity of gas, and how it would be affected when the current changed? If it would occasion any friction on the instrument, thereby causing it to work inefficiently? I do not think it would work effectively in a current charged with gas and explosive.

Mr WILSON—I do not see where there can be any difference in a current than out of it. If the specific gravity is really different it will act.

The CHAIRMAN—Then, gentlemen, it appears to me that the position claimed by Mr Wilson is this: that this instrument of his, surrounded by bad air, will indicate an alteration of the specific gravity in the air to such a degree that if two per cent. of fire-damp be present in the air then the alarum bell of the instrument will be rung. That seems to be the position claimed by Mr Wilson, viz., that this instrument bathed in bad air shows when that may be a dangerous mixture, whether of lighter gas or of heavier gas; and I would, believing it practicable, ask him if he has considered how it could be applied in a mine? Is it to be carried about by a person to detect such gases, or is it his

advice that it be set up as a permanent fitting underground? Then, if so, where he would select? These are matters which, of course, our discussion will fully bring out. There is no doubt that little germs of invention like this may lead to some more important, and I think that in the meantime we cannot do better than adjourn the discussion and accord a hearty vote of thanks to Mr Wilson.

Mr M. Ross—I saw the instrument tried in the mine where the explosive gas was, and according to the idea I have, it must be a fixture. The instrument when I saw it was not in such a complete state as at present; it wanted the galvanic battery and signal. The gas was highly explosive, and the moment it was put up it dropped nearly what Mr Wilson said, viz., an inch and a-quarter fully, and if the bell had been there it would have rung. My idea is, it must be fixed in the mine for some purpose. I do not think it will do to be carried about. Mr Wilson does not claim that; he only claims that it will detect the gas the moment it is put up.

Mr Robson—Could you not in that instance detect it with a Davy lamp?

Mr M. Ross—Certainly, you could.

The discussion on the paper was then adjourned.

COAL CUTTING BY MACHINERY.

Mr Robson having taken the chair, vacated by Mr Begg, invited the members to resume the discussion on Mr Begg's paper on "Coal Cutting by Machinery."

Mr Drinnan—The last time I was here, I heard of a Mr Jamieson who was making experiments on hard shale with a machine; has he not yet reported as to his success?

The Chairman—I think not, and he is not present. There seems to be no doubt as to the machines being able to cut the coal, but whether it is of any use adopting them in thicker seams is a question. I think Mr Anderson is the only gentleman present who has machines working in seams of 5 feet in thickness.

Mr Dixon—Before Mr Anderson replies, if he is going to do

so, I would just ask him to contrast the working of a certain number of faces with a machine and by colliers ; and if he would tell us as near as possible the actual difference in the cost of the coal, and also the actual difference in the proportion of dross to round coal ?

Mr ANDERSON—I do not think that anything that I know of it will meet the question that Mr Begg raised. I do not know anything whatever about a machine working in the ell seam to a height of 7 feet.

The CHAIRMAN—In point of fact there are no machines working in the ell coal where it is 7 feet thick.

Mr BEGG—There is very little doubt that in thinner seams the benefit is appreciable, not to say appreciated, but I purposely put it at 7 feet that the question might be made finer, and we might really turn our attention to discover any probable benefit that would arise if it were attempted.

Mr FAULDS—I do not think a coal cutting machine would be beneficial in a seam 7 feet thick.

Mr BEGG—Why ?

Mr FAULDS—Unless it was worked long-wall, and I think that would be very expensive.

The CHAIRMAN—You are quite aware there are 7 feet seams worked long-wall.

Mr FAULDS—I am quite aware, but I have not seen any of them yet.

The CHAIRMAN—If we don't agree with this proposed plan, we should try and show where it is wrong, point out its defects, and say where it could be improved. It seems to be well worth consideration at any rate. I do not suppose the paper was written with the idea that every one would fall into the writer's view of what could be done.

Mr BEGG—I did not write the paper with the idea that everybody was to agree with me with regard to the method I proposed to employ. I rather threw down a gauntlet, expecting the members would take it up, and we would then be able together possibly to arrive at a method of working that would prove of immense benefit to this district, for we must all heartily agree that if we could work the ell coal 7 feet thick, and save no more than half

of the dross, it would secure this benefit. It was with the view of suggesting this view to each one that my paper was written. There is perhaps no one present who has any actual experience of working a seam 7 feet high by long wall particularly, but I intended that each of us should take up the matter, and decide if it might not be applied. I do not think any one of us can deny the benefit it would be.

Mr DRINNAN—It seems to me that it would only be a profitless discussion to attempt to discuss the point if no one has been or is working the ell coal, and able to say he is working it at less cost than Mr Begg says can be done by machines. Unless some one submits figures of that kind it would be profitless to go on. Any one may say it will not work well, but then if the pertinent question is put to him—"What reason have you for thinking so?"—he is not able to give an answer and submit figures that would justify his assertion. It seems no one is able to give an answer of that kind, and the reason doubtless is that none of us who are working the ell coal have gone into the matter thoroughly.

Mr FAULDS—The reason I made the remark I did was that I wished to elicit further information from those who had it.

The CHAIRMAN—Still you can give your reasons why this particular plan won't work.

Mr DIXON—I think the latter part of my question as to the proportion of dross applies with greater force to other seams than the ell coal, because the ell coal dross is a good marketable article, but the dross of the splint and main is not. If you cut down the proportion in these, it is in favour of machines.

The CHAIRMAN—This very important paper has not had that amount of criticism from the members generally which it deserves. It describes very fully the successful employment of coal-cutting machines in two collieries, and then treats on a proposed mode of working seams of a greater thickness, such as the ell coal here, and the partial employment of machinery therein. It is clear that, as machinery is at present only employed in "holing," the thicker the seam the less saving will there be per ton of coal produced; and also where the coal is not difficult to hole by hand, the saving by machinery must be still less. It does not, however,

follow that it may not be applicable in these seams. Where the roof along the whole line of face can be maintained unbroken, to permit of the machine passing, by having the supports not nearer than 3 feet from the coal where it is holed, there appears to be no further obstacle in that direction. If this can be done then, unless the coal is very tender, it would probably stand until the machine passed, when it would be gibbed up close behind as the holing advanced. In this way with a cleanly cut, straight holing, such as a machine only can make, the coal, in every instance, is likely to be produced in better condition than by hand holing, if proper attention be given to the breaking and filling of it. With regard to the proposed plan of working, there is (1) the goaf roads for the conveyance of coal. These are built with material obtained from the fallen goaf, the roads not being brushed. Presuming that sufficient stone can be obtained in this way, which, however, may not be a very desirable method of getting it, and might prove as costly as brushing in some cases, it will be admitted, I think, that before the face advances 200 yards, those roads will not be more than half their original height, which in a 7 feet coal would be only $3\frac{1}{2}$ feet, so that it is rather doubtful whether brushing could be dispensed with entirely, unless the roads are cut off by cross roads at intervals of 60 or 70 yards. Then (2) as to the number of roads for each machine wall of 100 yards. In the ordinary mode of working long-wall, with roads every 10 to 14 yards, the proximity of the buildings prevents in a great measure the roof from falling at or near the face. In the proposed method, the distance between the buildings will be about 22 yards, instead of about 3 yards, and this portion of the face is intended to be supported by rows of chocks. Now, whether this method will be found practicable or not will depend very much on the roof for the first few fathoms above the coal, but I am afraid that the ell coal roof in most of places would be too strong, and would not break off so regularly and frequently as desirable for the success of this system. And (3) with regard to the system of working out blocks, 100 yards wide and 100 yards apart, with the coal partially worked between, I apprehend that at depths of 120 fathoms and upwards, the roads in the coal would be affected, and the coal crushed by the abnormal

pressure on each side. This evil would be considerably augmented when the ranges of pillars were being worked out; and I have, therefore, great doubt as to the machines being able to work back the pillars left in the panels.

Mr ANDERSON—I think, notwithstanding what has been said about the 7 feet seam, that the ell coal can be worked to advantage with coal-cutting machines. The difficulty at present is more in the filling of the coal than in the cutting of it. It may seem a little strange that after the coal is once got down there could be any difficulty in filling it. There is about as much difference in colliers breaking up the coal and putting it into the hutches after it has been undercut by the machine and taken down, as in colliers in the first instance taking it out of the solid. One man may make 30 or 34 per cent. in filling it from the machine; another man may fill with 15 per cent. of dross, so that in any case, as far as I have had the opportunity of examining it, there is a great advantage in having thoroughly experienced colliers, men who know how to break the coal. Between the machine price and the colliers' price when not cut by the machine, there is considerable difference. It is very much more than Mr Dixon indicated as what he had got. I refer to the ell coal, and I may say to the pyotshaw as well. It is very nearly the double what he said it was from the information he had got. But I do not know how we could manage to fill the coals with the roads Mr Begg has laid down on his plan. At Auchenraith we had them laid out in the first instance every 33 yards, and we found it impossible to get the coal filled with the roads so far apart, and had to bring them in to less than half that distance. It would be a very good thing indeed if two men could fill the coal cut. We have some that can fill about three times as as much as others. The same obtains all round. I have seen colliers going into a solid face of long-wall and doing three times what others would do. The quantity of dross depends more on the man than on the system, but I think that the ell coal of an average height of 5 feet at any rate can be economically worked with coal cutting machines. Mr Begg has given it as his opinion in the paper that the Baird's machine is considerably behind the other. That may be a matter of opinion. In some instances, I have no doubt the

Rigg & Meiklejohn is the better machine of the two. It holes to the pavement, and that is what the Baird's machine does not do. That makes the coal easier filled, and consequently you have a less percentage of dross, but I question very much if it will hole as many yards in a shift as the other will do. However, there may be some parties who are better able to drive it along. One may be able to succeed where the other is a partial failure. I think that coal-cutting machines have a great future before them, and it just needs people to know about them and they will go into them wholesale.

Mr BEGG—In the meantime there is only one point in what Mr Anderson has said I would like to correct. I hope none of you suppose I have expressed an opinion either for or against any one of the machines. I gave simply the result of my notes, and my calculations being correctly based upon them, they bring out the figures I have given in my paper. I can certify that the figures I give as to the work done by the machine per shift are correct so far as my notes relate to them. Otherwise I do not express any opinion on the machines, and I would just like to ask Mr Anderson if his experience of Rigg & Meiklejohn's machine does not meet what my notes show? I think that is a fair construction to be put on his remarks—viz., that his experience had not quite met the views I have stated. If that is the case, I do not think it will do any injury to the machine, although he plainly states so. I think it but due to the machine that we should plainly know the reasons Mr Anderson has for his remark.

Mr ANDERSON—I think what I said was perfectly explicit. I do not set up the one machine against the other. I say Rigg & Meiklejohn's machine does things the Baird's does not do. I just expressed a doubt—I have not made a calculation—as to whether it will cut as many yards.

Mr BEGG—My paper says more?

Mr GRANT—I think Mr Anderson is wrong as to the holing. Baird's machine holes in the pavement.

Mr RONALDSON—Does Mr Grant mean that it holes from the front to the back in the pavement?

Mr GRANT—It does not touch the coal.

The CHAIRMAN—In that case I suppose you have the pavement lifted up along the wall.

Mr GRANT—Yes. Just the depth that the machine takes.

The CHAIRMAN—Suppose you had no bottom lifted at all where would it hole? Would it not hole above the bottom of the coal?

Mr GRANT—It is 3 inches high in the front.

Mr HASTIE—I would like to ask Mr Anderson if he would be inclined to let us know how much percentage of dross he has in the ell coal where it is worked with the machine?

Mr ANDERSON—I don't need to answer that. I have made a statement that you well understand. It depends on the colliers—some make 15 and some 35 per cent.

Mr DIXON—I must rise to repeat Mr Hastie's question, because that is a truism Mr Anderson has just stated. We all know that certain classes of colliers make more dross than others; but take an average face or number of faces with a machine and some with colliers, is there any difference, and if so, what is it? It is a simple question. There is another thing I would like to ask Mr Anderson, if he can answer it, viz., as regards the length of roads. For instance, Mr Begg has drawn out these blocks—200 yards long and 100 yards broad. Would it be better to have them 50 or 100 or 200 yards long? In former evenings I criticised Mr Begg's plan, and I need not repeat what I then said. I think my remarks come to very much the same as Mr Robson's, especially as regards the blocks of coals between the areas of waste being rendered very difficult to take out and very much crushed by the very fact of this waste existing on each side of them.

Mr ANDERSON—I think it is better in the working of machines to have no blocks of coal between the two places at all. If you will have three or four machines cutting, in my opinion, the better way is to have the faces where the machines cut so arranged that the one is about 40 yards ahead of the other. Say your No. 1 machine has a length of face 150 yards, with roads, 12 or 14 yards apart; your No. 2 machine would be about 40 yards behind with the same length of face and distance between the roads, and the same with the third and fourth. You thus avoid the waste of the coal being crushed in the pillars by Mr Begg's plan; but the breakage of the

roof is different when machines are at work. The wall face being nearly a straight line, it follows that the breaks on the roof are the same, and the roads, being at right angles to these, stand much better than in ordinary long-wall, from the stones of the roof being in long lengths and the ends getting supported by the buildings at the road-side; but it is more difficult to drive a slope-road along the face, as it has to be driven nearly parallel with the line of break in the roof, and for a certain distance up (in some kinds of roof) the distance between each break is about equal to the depth that the machine undercut the coal.

Mr DIXON—That is very valuable information. There is another remark Mr Anderson made as regards the proportion of saving in labour. I am glad to hear it is much more than I said. I said it was as 3 to 4, and Mr Grant said in the proportion of 60 to 90. Mr Anderson, as I understand, now says it is in the proportion of 2 to 4, which is a very great difference indeed.

The CHAIRMAN—Regarding the long roads, I suppose they would need to be re-brushed if you continued them beyond say 100 yards?

Mr ANDERSON—There are roads nearly 100 fathoms and no brushing taken off but the first brushing.

Mr HASTIE—I am not quite satisfied with Mr Anderson's explanation. I have seen the ell coal produced in this district with the picks and the men with about 30 per cent. of dross in the solid and 40 at the stoops. I would like to know if the machine is less? That is not going into detail.

Mr ANDERSON—I have stated it plain enough already, I think.

The CHAIRMAN—No, you have not given it as plainly as Mr Hastie wants it.

Mr ANDERSON—Perhaps I don't know how to express it.

The CHAIRMAN—Mr Hastie says in solid workings he has had 30 per cent. dross, and in stooping, 40 per cent. dross. That was general over the whole pit. How does yours compare with that? Take both solid and pillars at 37 per cent of dross; does long-wall by machinery produce a less proportion of dross?

Mr ANDERSON—A very much less proportion.

Mr HOGG—I have only one question to ask. It is as to the airing of the places. Supposing the air goes up the left hand road,

there are 16 yards of face to the left of that road and no way of taking in air except by bratticing of some kind. It is the same again on the other side of the machine wall; there are 15 or 16 yards there also requiring to be aired.

Mr BEGG—This (pointing) will be closed here.

Mr HOGG—I see that a cundy may be left along the rib side, but is the expense of keeping that taken into account in calculating the cost?

Mr BEGG—Clearly; the cost of building one side of the road is calculated, and that air-course is between a building on the one side and the coal on the other.

Mr HOGG—Yes; there are 15 or 16 yards of waste between the roadside and rib, but it might be difficult to preserve an aircourse there.

Mr BEGG—I shall take up Mr Hogg's remarks before entering on the general discussion on the paper, and in doing so it is really necessary to consider how members deal with such details. Each one finds fault with the mode proposed by his neighbour. That was really what I foresaw, and therefore in the method proposed I did not go into all the details. I propose a general plan, and I know perfectly well if Mr Hogg or Mr Drinnan or any other member was sitting down with this general plan to work out they would feel little difficulty under it, but each would successfully pursue his own method, and that is the reason why I did not give any precise methods for airing the places or for drawing the coals seeing that would just complicate the discussion which I wanted to raise on the general question of working a 7-foot ell coal by machinery or not. Now, in the general argument of the question, so far as I have gathered the opinion of the members, they agree that in a small seam nobody thinks of questioning the merits of the mechanical method of holing. These merits I think are clearly established by the progress that has been already made in introducing these machines, and further, we have Mr Anderson's experience of the fact that in a big seam of coal (they are 4½ and 5 ft. thick at the collieries he represents) the saving of dross is very considerable, and that the actual saving in price for holing is also considerable—much more than was already assumed. The paper that I have given deals with two machines

simply because it is the only two I have seen. I have already said I did not want to raise any question between one machine and another. I am not competent to do such a thing as that. I merely gave the results as I found them with some calculations that I made thereon. It comes out that the one machine holes more than the other and so saves a considerable proportion of the price per yard. That is of course entering into the details of the question as between the machines, but there is no mistake that the relative circumstances under which each machine is placed must considerably affect the results. For instance, if in the circumstances I saw the Rigg & Meiklejohn working at Dalkeith the Baird's had been placed, the results might have been the same as I have given for Baird's as at Bothwell Park. Put the two machines down side by side as Mr Anderson has done, and then one may compare the one machine with the other and state definitely what the respective merits are. I was not in a position to do anything of the kind; therefore I hold I must not be supposed to compare the one with the other at all. Mr Dixon having adopted a great many improvements at his colliery in this district no one can accuse him of shutting his eyes to invention or being unfriendly towards it. Therefore, I think the protestations he made that he was not to be supposed to be against coal-cutting machinery were unnecessary, for the members will give him the credit of being fully awake to all the benefits to be derived from it, and I know that the position he takes up in first of all advancing against the machine, is not from any sceptical ideas, but more to get at *bona-fide* information—information he can rely upon. Now, this is not to be had in regard to a 7-ft. ell coal from the experience of any of us. At the same time, I think he went too far in objecting in the terms he did to machinery, because he insinuated that these coal-cutting machines must be left alone until they can do a great deal more work—secure more appreciable advantages than at present—until, in fact, they can draw their own coals and bring them to the shaft bottom. If it be taken up in that spirit, consideration of this question will lead to no benefit being got. If we are content to have the saving that coal-cutting machinery is at present in my view calculated to bring to us, then I hold we do a considerable benefit to the trade

by giving opportunities for improvements to be made on the machines we have at present, and we must give encouragement to inventors, before they will advance to our views and meet all our circumstances. Let us be presently content with the results we have, and improvements on the machine will no doubt come shortly. Now, as to the objections made to the plan I have proposed, I did not reckon on this question passing off so easily as it has done. I expected that a method would have been worked out by all the members, and this has not been done. The members generally have contented themselves with finding fault with one little corner and another, but not in such a way as any of us could say that a particular method of working out thick ell coal by long-wall had been found, and that is a problem I am most anxious should be solved. Is it practicable, taking the ell coal as we know it, 7 feet thick, to work it by long wall, and if so, why not do it by machinery? These were the questions I put to myself in writing the paper. All that I have done in the matter has been very little indeed compared with the benefit to the mode to us all if we could have solved the problem. Irrespective altogether of the saving from the less quantity of dross made, I am convinced that there would be a pretty substantial saving in wages, and although my method is crude and generally found fault with, I think my figures clearly establish that the method I propose would result in a saving for you. That is one thing I have not been shaken in. Even the method I have proposed would tend to greater economy, and surely a much better method might be worked out resulting in much greater economy, and I would like if each one of us would earnestly take up the matter, for it affects much more than our individual prospects. It affects largely the district we are in; it affects, indeed, the future of our country to a great extent, the economy that can be brought to bear on the question of working out thick seams of coal, and I still hold the present method is most wasteful both in actual power and of a very valuable material. I have just to thank the members for the friendly way they have taken up the paper.

Mr ANDERSON—I admire Mr Begg's modest, unassuming way and the manner in which he takes credit to himself for his method being A1. He says he has been found fault with in holes and

corners, and no really practical method suggested in its place; but as I mentioned before I have practical experience to fall back on, and although I had not made a calculation, I think I did state I had tried a system that agreed with the very plan that he proposes. Perhaps my practical case is a failure, and Mr Begg's will be a success, because we have tried it and we had to fall back on roads very much less distant apart than 33 yards. The system Mr Begg suggested was found fault with, therefore, and I think he must admit there was another put in its place when he was told that we had tried it and could not get it to work and had to fall back on another with more roads and the same length of face. I think that could scarcely be said to be finding fault and not suggesting a remedy. It may not be satisfactory to Mr Begg, still we could not do it without the roads.

Mr DIXON—Though it is quite irregular, I must ask the indulgence of the members for a moment. Mr Begg has misinterpreted what I said in saying that I wished to let machines alone until found perfect. I certainly said that I thought machines should do more work than they do, and I threw out a hint about a plough in a jocular way, but I never said to leave them alone until perfect.

Mr BEGG—I did not make the assertion that you said, but that you insinuated we should let them alone until they are perfect.

Mr DIXON—If the members think I did so, I wish to correct that. I did not intend to insinuate that. It is necessary to be going on working with the machines, and thus finding out and overcoming difficulties to be perfect, and I am most anxious to see them perfect.

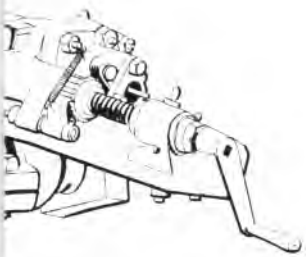
The CHAIRMAN—I did not expect Mr Begg was going to reply finally when he began; I thought he was simply going to answer Mr Hogg's question.

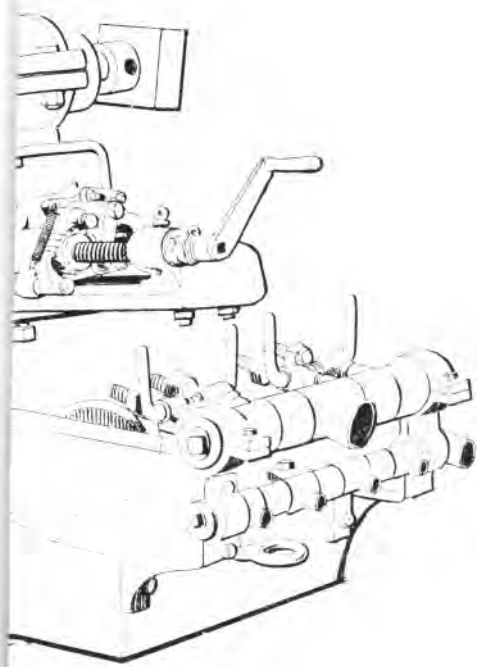
Mr SMART—I was not aware either that Mr Begg was going to wind up, as I wanted to ask a question or two. We all know that in the ell coal in this district, to the east of us the roof is very much different from what it is in the west. Where we are just now we are almost in the line of distinction. To the east there is a rotten roof of several fathoms, and about 3 feet of coal is left in the roof which we don't take down at all, whereas, to

NG MACHINES.

PLATE I.

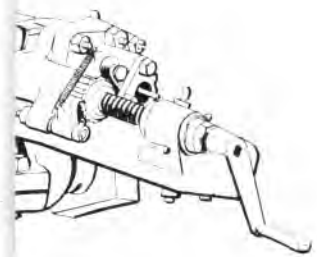
M.J.S.





NG MACHINES.

PLATE I.
M.J.S.



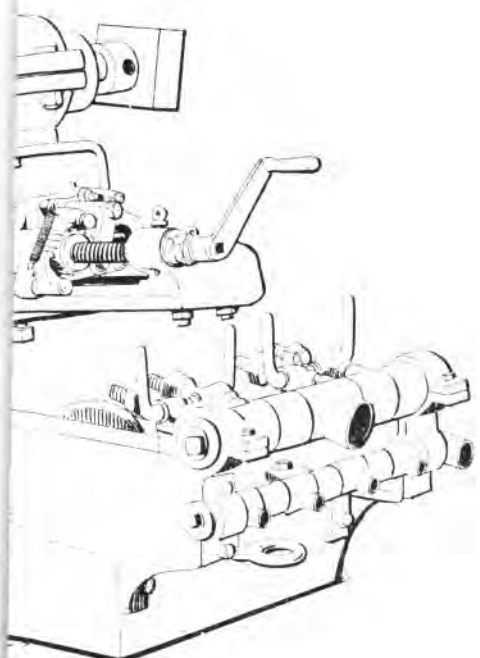
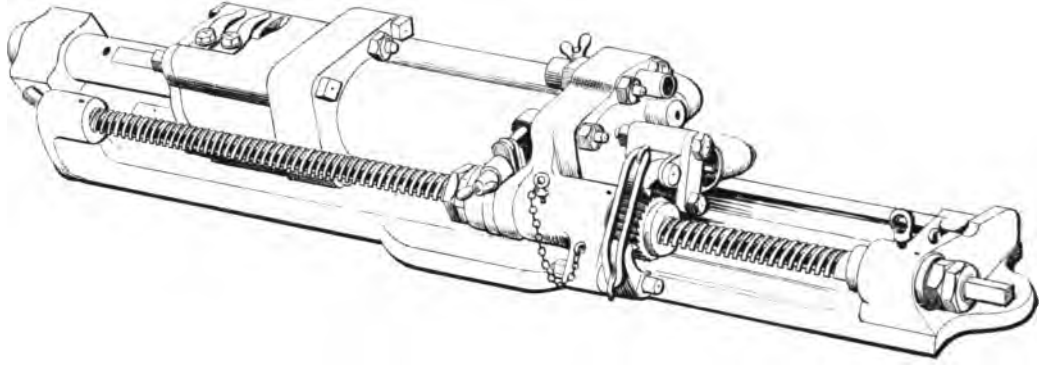


PLATE 2.
M.J.S

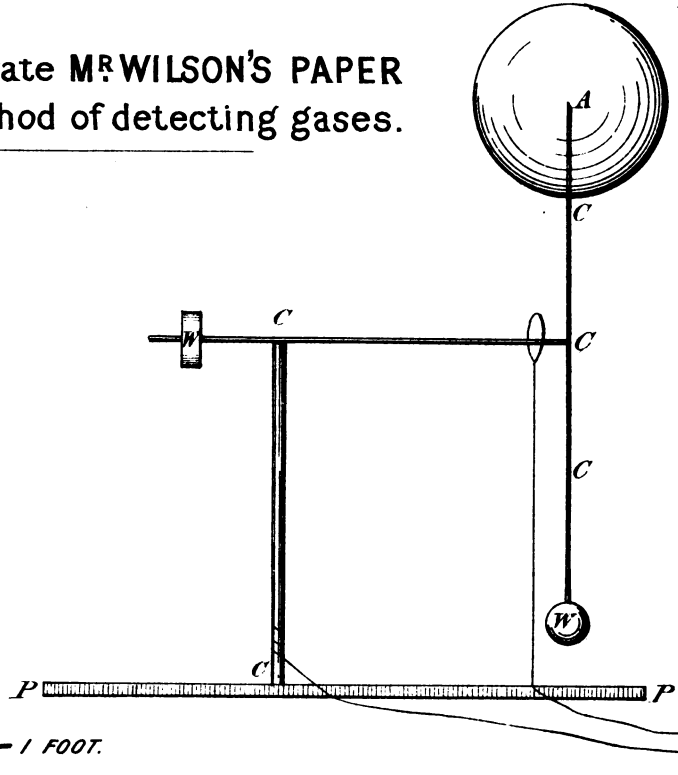


BEAUMONT & BICKNELL'S
BORING MACHINE.

BALANCE FOR DETECTING GASES.

PLATE 3.
M.J.S.

To illustrate MR WILSON'S PAPER
on a method of detecting gases.



REFERENCE.

A	*Airball.*
W.W.	*Weights.*
P.P.	*Sole of Wood.*
C.C.C.C.C.	*Copper Rods.*

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING, 24th JULY, 1880,

HELD IN THE

WATERLOO HOTEL, EDINBURGH.

RALPH MOORE, Esq., President, in the Chair.

The SECRETARY read the minutes of the last meeting, which were approved of.

The following gentlemen were then admitted as Ordinary Members :—

JAMES NASMYTH, Coalmaster, Donibristle Colliery, Crossgates, Fife.
ALEX. H. NASMYTH, Mining Engineer, Donibristle Colliery, Crossgates, Fife.
WILLIAM MACKENZIE, Mining Engineer, Newbattle Colliery, Dalkeith.
T. LINDSAY GALLOWAY, Mining Engineer, Laurel Bank, Oakshaw Street, Paisley.
JAMES MORTON, General Manager, Langloan Iron Works, Coatbridge.
JOHN PATERSON, Coalmaster, Oak Villa, Uddingston.
WILLIAM WILSON, Colliery Manager, Dykehead Colliery, Larkhall.
JOHN M'DONALD, Colliery Manager, Greenhill, Holytown.
ROBERT CALDERWOOD, Colliery Manager, Oakbank Shale Works, Mid-Calder.
ALEXANDER RIGG, Colliery Manager, Dykehead Colliery, Hurlford.
HENRY NESS, Colliery Manager, Muircockhall Colliery, Dunfermline.

Other nine gentlemen were then nominated as Ordinary Members, and will be balloted for at the first meeting.

The PRESIDENT then addressed the Meeting, and said—When you sanctioned a meeting in Edinburgh, the Council thought it would be desirable that we should see some collieries near Edinburgh, and through the kindness of Mr Aitken, Chairman of the Benhar Coal Coy., we have been

enabled to see the Niddrie workings. Mr M'Callum, the general manager, promised to do what he could; and that being so, I thought it desirable that we should have a short paper from either of those gentlemen on the Niddrie Colliery, and on its coal workings, which you have seen to-day. In accordance with that idea, Mr M'Callum kindly undertook to give a paper on the Lothian Coal Field, which we will now hear. (Applause.)

THE LOTHIAN COAL FIELDS.

By ALEX. M'CALLUM.

I KNOW there must be many here who are far better qualified than I am to give a description of these coal fields which you have just visited, and also of the mode of working such fields; but, having been asked to do so, I trust you will overlook all defects. The Mid and East Lothian coal fields extend a distance of about 12 miles from east to west, and at least 18 miles north and south; but, as a great number of the seams enter the sea at Joppa, and along the coast eastward from that place, it is not known how far they may extend northward. It is supposed by some very competent judges that they extend across the Firth of Forth into the county of Fife, and are those being wrought there to a considerable extent at the present time. The dip is to the east, at a very great angle on the western outcrop.

These fields, within the area I have mentioned, contain between 50 and 60 seams of coal more than one foot in thickness, and give an aggregate thickness of coal strata of 30 fathoms, or an average of three feet for each coal seam. It has been assumed that of this there are about 180 feet of workable coal, and that altogether there are (after taking into account the loss from faults, &c.) about 3000 millions of tons, or about a sufficient quantity to last Great Britain for 65 years. They also contain a number of very fine seams of blackband ironstone of from 4″ to 10″ in thickness, and a number of posts of limestone of superior quality.

As it is the edge seams in these fields with which we are more immediately concerned to-day, I shall now endeavour to give a short description of them. At Niddrie, these seams are lying at an angle of from 45 to 83 degrees with the horizon, and dipping into the vale of the River Esk from both the east and west. It is supposed by many authorities upon such matters that, about the place where that river is now wending its way through Midlothian, we may expect to find the bottom of the basin of these edge seams, and it is computed that the lowest of these metals cannot be less than 800 fathoms below the present surface.

I have said that the edge coals lie at an angle of from 45 to 83 degrees, and the question often arises with me when I am looking upon these metals—Were they laid down originally in the state we now find them, or were they deposited in a horizontal direction? My opinion is that they were laid down at an angle of, say 12 or 15 degrees, and must have extended beyond the situation of the hill known to us as Arthur's Seat, before the crop of the lowest of them could reach the surface. After having lain there for perhaps untold ages, at length a time came when the gases, which had been accumulating for a long period of years, burst the bars of their confinement and sent, with a terrible force into the air, that great mass of material which we now designate Arthur's Seat, and also the materials which form those hills to the south and east of these fields.

We may readily conclude what would be the result after the throwing up of all these great masses of original rocks of the earth. According to all known law, a great cavity would be formed in the space formerly occupied by the molten matter which had just been expelled, and the whole of the stratified metals which existed above would be left for a time hanging in space. These, however, after a time, being weakened by suspension, would break and drop into the great gulf below.

It is more than likely that, by this time, the boiling liquid up towards the mouth of the crater had partly cooled, so that the metals at or near the outcrop would be kept from sinking; hence the metals are lying at the angle we now find them. This break must have taken place somewhere in the district we term the basin of the river Esk. Now that we have got these valuable

minerals lying in the position you have seen, the next question is —What is the best method of getting them extracted from their present beds and sent to the surface, so as to give the men who are employed to do this work the best security for the preservation of life and limb; at the same time, to give to those who may have their money invested in these undertakings, the best and most profitable returns; and lastly, to secure the greatest possible quantity and the best quality of the coal for the great benefit of all?

I will first name a few of the different seams found in the field. The seams, gentlemen, you have seen to-day, are called respectively the "Great Seam" and the "Stairhead." These seams lie at or about the centre of the basin. The "Great Seam" is the best in connection with the edge metals we have in our district, because of its containing a very good gas coal. It runs altogether about 8 feet in thickness, 5½ of which is a very good steam coal, and 2ft. 4in. of it being almost the first quality of gas coal. There is also from 3in. to 5in. of very good ironstone in connection with the working of this seam. About 30 feet below this position is the "Stairhead," also a very good steam coal, about 3ft. thick, in connection with which is a third-class gas coal of very good quality and about 2ft. 4in. in thickness, and a superior kind of ironstone of from 6in. to 8in. thick.

There is a third seam, lying about 60 fathoms above the Great Seam, called the "South Parrot." This I have not yet seen, but I believe it is a very good splint coal, and contains a gas coal of good second class quality, having a thickness of from 12in. to 15in.

The last seam to be noticed here is the "North Greens" or "Jewel." This coal is noted for its good quality, being, I believe, about the best for housebold purposes in the market, and at all times commanding a very high price. There is also a first-class gas coal about 7in. thick connected with its working. This seam, occupying the lowest position in a field about 800 fathoms deep, will consequently not be very easily wrought to the bottom. Taking the field as a whole, it is, in my opinion, one of the richest mineral fields in Scotland.

You have seen to-day, although very imperfectly, the mode of

working which has been adopted at Niddrie Colliery. Whether that may be the best method or not is a question about which there may be many and various opinions.

As you have had so little time at your disposal to make a full investigation into the details of the system we pursue in obtaining these coals, &c., I shall, for your better understanding, give a short statement of our mode of procedure.

The practice has been, and is still, when the strata lies at an angle of 45 degrees or so, to commence at the surface and sink a shaft or "incline" in the seam of coal, breaking off levels every 30 or 35 feet to the right and left of the incline, and driving these levels, say for 200 fathoms. Upsets between the levels are put up every 160 feet or thereby. We then put down a drop incline on each side of the main shaft at the 200 fathoms, leaving a stoop of 20 fathoms on each side of this drop to protect it. We next go back towards the point where we first started, working out the stoops as we go along, and making sure to keep the top stoop always from 25 to 30 feet in advance of the one following. In this way we work on to the undermost place. While we are working these stoops, we are, at the same time, driving ahead with the levels and dropping the materials got down these drop inclines to the bottom or lower level, where they are taken to the main incline or shaft by means of horses. I may say here that the break we use is the ordinary drum set upon a wooden frame and having two wire ropes attached—one for working the carriage which lowers and raises only one hutch at a time, and the other for working the back balance which is used for taking up the carriage and the empty hutch.

The levels or fast places are driven about 8 feet wide or 8 feet high (as you would say), and secured with bars and props as they advance. These bars and props are rather troublesome, requiring often to be renewed before the stoops are got out the distance wanted; but, as there seems to be no other way of properly securing the roads, they cannot be dispensed with.

These stoops, as you will have observed, are about 20 or 24 feet in height, and about 160 feet in length from upset to upset.

When the metals are lying at an angle of 45 degrees, they are quite easily taken out, and the expenditure is much less than in

the driving forwards of the levels, so far as the miner is concerned; but as much money requires to be expended on wood for the maintenance of the roads, &c., the cost is not much diminished per ton on the whole from what it is in the cutting of the levels. The distance we run our breaks or inclines is about 70 fathoms or 12 places. We have travelling roads to put up from the bottom level to the top one. The one-half of the men go in at the top, and the others at the bottom, and as each man requires to travel up and down the "traps" provided to get to his work, he thereby loses a good deal of time which is saved in flat workings.

In one of our pits the whole of our workings are almost vertical, and the shaft is sunk in the seam or nearly so. The levels are broken off right and left as before, and after having been driven to the point required, a drop is put down and a return is made with the stoops in the manner before described. The perpendicular stoops require a great deal of care in the working and setting of wood. The miner, having no other footing than the props and a footboard, which he sometimes uses to do his work upon, is generally suspended from ten to twelve feet above any rubbish which may have accumulated in his place.

To many of you this may seem to be a very dangerous piece of work, but with care and skill it is not so; besides, every particle of coal is got out, at least to the same width, as it was when the levels were being driven forward.

It has been suggested that we should try to work these seams long-wall; but I am not quite satisfied that this mode of working would be any improvement. In fact, I am almost convinced that, owing to the width of the seam, the nature of the partings, and the brittleness of the roof and pavement, it would be impracticable in the Great Seam, at least. Perhaps some of the others could be wrought with greater advantage under the long-wall system than by stoop-and-room; but in my opinion the Great Seam could not, because of the reason given.

In these edge coals we have another difficulty to contend with which is not often met with in flat workings, that is the pumping of the water. As we must be continually sinking, we have great difficulty in keeping our pumps in working order. When the

least thing goes wrong, the water is up over the working parts, and if a bucket or a clack chances to get lost at that time, great annoyance and a good deal of expense is the result.

Further, the water always goes downward and to the lowest point, and, as the metals crop up to the very surface, in wet weather it is with great difficulty that the water is kept under. In flat workings the water can be cut off into lodgments and thus a smaller set of pipes is required, thereby lessening the expense, care, and trouble. If there be a good bed of fire-clay below the lodgment, there need be little fear of the water going further down.

The signals are also of great importance with us, as indeed they must be with every one; but in our case they require more attention than in flat workings. In the latter case, all the material is, for the most part, sent from one bottom, while with us every place has its own bottom, and therefore must have a separate and distinct signal. It may seem to some of you that, in bringing our material by means of horse power to the main incline, only one signal is required, but we require one in each place in our drop inclines, and these, for a double purpose, viz.—for signalling to the brakesman and to serve as a fence to prevent any one from falling down the incline. The system we have adopted is one which I believe our worthy President has had much to do with in bringing it up to the present state of efficiency, whereby it affords safety in working when properly attended to. The mode of erection is as follows:—

Two levers between 4 and 5 feet long are placed at right angles to each other. The end of one runs into the shaft, while the other is fixed to its outer end and forms a bar across the mouth of the shaft when not raised by the signalman. These signals are the means of adding considerable expense to the working; first, in the material used; secondly, from the labour required in making and fitting them up, as they must be put in a proper place and at a particular height; and lastly, in keeping them in working order.

THE PRESIDENT—In accordance with our rules and with the work we have to do, I think we should have no discussion on this paper. All of you, however, I believe, are satisfied that we did well in accepting Mr M'Callum's offer, for he has given us a

very interesting paper. These edge seams are particularly interesting. You have nothing so steep in the west country, yet the same seams are there; that is to say, these Niddrie seams are the same as the Cowglen, Possil, and Kilbirnie series of coals,—the coals below the limestones, not the Wishaw and Hamilton seams, although all these are here higher up in the section, and are called the "flat coals." I was just wondering whether Mr M'Callum was not rather deep in his estimate of 800 fathoms, nearly a whole mile deep. I think it is much less. However, we have an extraordinary difference in the thickness of the Cowglen series of coals. At Lesmahagow, where the gas coal is at its best, they have not so much common coal in this section as fire their engines, while we have here 70 feet of coal. That is a very curious thing. The North Greens Coal—here a very good house coal—is just the Hurlet coal, which is not a very valuable seam generally. The iron stone and gas coal, which lies above the North Greens coal, is also present at Hurlet, and particularly at Campsie. I do not know exactly the position of the North Greens coal in Fife, but at any rate the Lochgelly seams, from the first of them down to the splint coal are just the same seams as what we have been seeing to-day. Well then, the South Parrot, as Mr M'Callum told you, is just the same parrot, I believe, as what is worked at Capledrae, Lochore, and at Overtown in Fife; and the same as at Rigside, near Douglas, in Lanarkshire. Coming up, we have first the Cowpit coals and second the Jewel coal, &c.; the first represented by the Dysart coals, the Bathgate coals, and those near the Slateyband Ironstone; the second by the Wemyss coal and the Glasgow Splint coal, and those above it. At one time it was thought there was no connection between the Edinburgh and other Scotch coal-fields, but they are now pretty well classified. Without saying more on that subject, I think we have had a very valuable paper from Mr M'Callum, and while we acknowledge that, I think we are very much indebted for the very pleasant outing to-day at Niddrie to Mr Aitken and Mr M'Callum; and in proposing a vote of thanks, which I am sure you will all agree to give, to Mr M'Callum for his paper, I should also unite with it, a very hearty vote of thanks to Mr Henry Aitken, the Chairman of the Benhar Coal Coy., and also wish hearty success to the

Benhar Coy. (Cheers). I knew we would be well treated, but I must say I was not quite prepared for the very kind way in which we were treated to-day. (Hear, hear). I am sure all of you must feel it, and I think we cannot do better than convey a hearty vote of thanks to Mr M'Callum and Mr Aitken, and wish every success to the Benhar Coal Coy. (Cheers).

Mr AITKEN—When you were kind enough, sir, to ask me to read a paper on the Edge Seams of Coal in the Lothians, and on what I supposed to be the proper method of working them, I felt that I knew just sufficient about it to know that I did not know about it. There is nothing easier than for a man to speak of a thing he knows a little about; and I think you are much better in having had Mr M'Callum's paper giving you, I think, very shortly and tersely a description of the fields and of the manner in which we work them. Whether the manner in which we work them is the manner I would adopt, or the manner of fitting the colliery is the one which I would adopt, I am not prepared to say. Perhaps in many matters I would alter the present system, and in others again I would follow what we have. I would simply thank you for your kind wishes, and hope we will see you back when the company has pulled through its troubles. (Cheers.)

Mr M'CALLUM—I have also to thank you very kindly for the way in which you have received my paper. (Cheers.)

PUMPING ARRANGEMENTS.

The PRESIDENT—The next is a paper which will be read by Mr William P. Barclay, San Francisco, on

A HYDRAULIC PUMPING SYSTEM.

Mr BARCLAY—In introducing to the engineering public the designs of a new hydraulic pumping system, we will dwell first upon the main features which constitute that system of hydraulic pumping that already has been put into operation at several

mining localities in this country and elsewhere, and then give a general description of that system of hydraulic pumping which we are confident will compete with its rivals.

In mining locations which had an abundant supply of water on head above the surface of mines originated that system of hydraulic pumping in which a natural head or pressure of water is made to actuate the pumps for draining the mines, and from this system again sprung the artificial pressure system by which a steam engine is used for the creating of a sufficient water pressure by which the force-pump plungers of hydraulic engines are put in motion, and made to force up a column of water three or four times or more greater than what is used for supply of hydraulic engine.

This does not, however, decide that what has already been done is the only or best way. The hydraulic systems which already have been put into actual practice have disadvantages in connection with them which we have been trying to remedy the evils of, and also to so combine the present force pumps of spear-rod pumping system in such a way that the wood rods thereof can be entirely dispensed with, and the remaining portion of the pump plant transformed into an hydraulic pumping system.

Hydraulic pumping as it now is accomplished in mines is objectionable in a number of important features. When a steam engine is used as the motor power to the hydraulic engine, the water which transmits the power to same is forced through a system of pipes having sharp turns leading to valves whereby a considerable amount of power is wasted in forcing the water through these sharp-turned pipes, over that which would be required if the same pipes could be more nearly straight. The valves also of the hydraulic engine and the valves of the force pumps, which are worked by the steam engine, are required to be put under a pressure so great (when the mines are of any considerable depth) that the valves themselves, in being worked under so much pressure, are a source of trouble and annoyance to keep in proper working order.

The questionable practice of placing the hydraulic force pumps out of the direct line of pit shaft, entailing decidedly a greater

trouble and expense than if the pumps had been kept in a perpendicular position, and that the same could be raised or lowered direct when required by the hoisting crab at the surface; The compounding of the hydraulic engine with the force pumps in such a manner that the entire engine and pump require to be thrown aside should a different size of either of them require to be used, is not the most preferable way of having your hydraulic engine and force pumps made; and any class of hydraulic, or combination of hydraulic and steam, pumping machinery, when so many complicated parts are placed in or at the bottom of the mine or shaft, is a great detriment against the keeping of such under proper repair. Connecting a steam engine with a system of force pumps having valves through which the water is forced to an accumulator, and from this accumulator conveyed to the several hydraulic pumping engines, through the valves of which the water also must be forced, is a very round-about way of transmitting the power of a steam engine to the several force pumps used in draining a mine; and from the very arrangement and complication of same, it is at once evident that could any other system of hydraulic pumping be devised, by which the power of steam engine could be communicated more direct to the face pumps, that a much larger duty would be attained per pound of fuel consumed.

Having alluded briefly to some of the main features of what has already been done in hydraulic pumping, we now beg to submit that system which we think will compare favourably with any of the hydraulic plans that have as yet been placed before the public.

Refering to Plate V, is shown a compound pumping engine and to the side of large steam cylinder (A) is secured a working barrel (B), into which works a ram (C). Passing through a stuffing box at upper end of barrel, this ram forces out the water that is in the working barrel (B) on the down stroke and through the medium of the water that is contained in the pressure pipe (D), leading from lower end of said working barrel, is conveyed or transmitted the power of steam engine, so that the plungers (E) of force pumps are also made to descend by the pressure of water acting upon the ends of the spear rods (F) from the plungers of

force pumps, these spear rods passing through a stuffing box at the lower end of their working barrels (G), and which are shewn bracketted from the discharge column (H) of force pumps.

These force pumps are not necessary to be of any special pattern, but any of the many different designs now in actual working are as suitable for the purpose as what has been shown. At a glance it will be noticed one special feature of the design is the absence of any valves in the hydraulic part of our apparatus, and the transmitting the power of engine direct to the spears (F) from the several plungers of the force pumps.

The force pumps (J) have the usual inlet and discharge valves, the distance between the pumps being the same as ordinarily erected at present in the mines. This arrangement gives the highest working pressure that pipes can be got to work under with safety, and at the same time the valves of the force pumps are not under any greater pressure than they are under with the common system of pumping with spear rods.

From the same centre in engine beam from which the ram (C) that forces down the water is secured, there are suspended steel wire ropes (K) that pass down one on each side of the force pumps, and to these steel wire ropes are secured the different plungers of force pumps, all of these plungers having crossheads (L) suitable for the clamping of them with the steel wire ropes, so that on the up stroke of engine beam the several plungers of the force pumps are lifted up. The spear rods (F) of the different plungers at same time causing the water through which the power of engine is transmitted on the down stroke also to be forced up by the pressure (D).

The confined weight of this column of water and wire ropes, with the several plungers, can be kept considerably less than the weight of the column of water forced up from the mine by the plungers of force pumps, thus doing away materially with the dead weight that is put in motion and oscillated at each stroke of the engine as is the case in the wood rod pumping system, and also relieving to a large extent, the excessive strains put upon the moving parts of the pit machinery.

From the side of the working barrel (B) for ram, is connected a valve chest (M) with a pipe (N) leading to underside of valve,

and this pipe can project up above the chest to any convenient height, so that as any water may leak from the stuffing boxes of the spear rods (F) of plungers, that the valve in said chest will at once open and allow the same amount of water to enter the working barrel (B) that may leak from the said stuffing boxes.

Another novel feature in the arrangement—that while other engines have used a column of water to work the pumps in the mine—this column of water they use is continually a fresh supply of water. In this new arrangement however, the water that is in the pressure pipes (D) always remains there except as has been stated before. The small quantity of water that may leak from the stuffing boxes only has to be supplied. Also, the bends in the pressure pipes can be kept so nearly straight, that the column of water used here may be much smaller, as it can be given a higher velocity than in the systems that have as yet been adopted.

From one of the mines not far from this district, I have noticed the weight of the pump rods and connections for comparison with my hydraulic arrangement. I am not prepared to say, however, that the same difference in the weights would be in all cases as great as in the present comparison, but, for mines of one thousand feet or more, the weight of pump rods in the spear rod pumping system, are generally a great deal in excess of what is necessary to do the work of balancing the water forced up from the mine. The weight of the pump rods and connections put in motion in the case above alluded to amounts to fifty tons. This includes the weight of piston and rod and a certain portion of the weight of engine beam, while the column of water forced up by the plungers is only thirty-two tons, shewing an access of eighteen tons of more weight than is necessary to do the work required, so that counter-balancing must be added to the same amount, hence putting in motion a total weight of sixty-eight tons, or thirty-six tons more than is equal to the weight of column of water pumped up from the mine.

In the hydraulic system alluded to, a total weight of seventeen tons put in motion would be all that would be required to do the same amount of work, as the weight put in motion on this plan can always be kept to about one-half of the weight of water forced

up from the mine by the plungers of pumps, and an engine one-half the size and double acting, would do the work required and dispensing with the balance beam and weight with which it is loaded.

For comparison, I have also added the weight of material used in construction for both systems of pumping. The weight of the pump rods, balance beam, and balance weight amounts to seventy tons, and in the hydraulic system the weight of the material in the plungers, spears, ram, steel-ropes, and pressure pipe only amounts to twenty-two tons.

There would also be a saving in weight of material used in having the pumping engine double acting, as an engine considerably less in size would just be as suitable as a single acting, as is the case at the mine from which I have taken the data for comparison of the two different systems.

Having alluded briefly, and made a comparison of the hydraulic with the spear rod pumping system, I will now consider another system of pumping water, which, I hope, will be of more or less interest to the most of you present.

First of all, I may term the pumping arrangement to be described an atmospheric system of pumping water.

In mines of great depth, say from two thousand feet to four thousand feet, the wood-rod pumping system is, I consider, little else than a humbug to continue the erection of pumping machinery on that system, as the weight of pit machinery, at such depths of mines, becomes so enormous that the weight required for ballancing purposes alone amounts to four or five times more than the entire weight of the column of water forced up from the mine; and to overcome the difficulty of putting in motion such an enormous amount of dead weight, I was led to devise out the arrangement to be described.

At the surface of the mines I place an exhausting engine (A, Fig. 1, Plate VI.), and from the inlet valves of cylinder of said engine there is conveyed a pipe (B) which reaches down to the bottom of the mine. The force-pumps (C) are placed at convenient distances apart, one above the other, and each force-pump has an atmospheric engine in close proximity with it. This atmospheric engine having a beam (D), and piston, and

piston-rod working through the stuffing box in cylinder cover, one end of the engine-beam reaches over and secured to the plunger (F) of force-pump, the opposite end of beam being pivoted to a foundation-block as shewn.

The cylinder (E., fig. 2, plate VI.,) of the atmospheric engines having a valve chest and valve which admits and relieves the atmospheric air to and from the opposite sides of pistons of atmospheric cylinders, so that as the pressure of the atmosphere is allowed to enter one end of cylinder the air on reverse side of piston is allowed to exhaust into the large pipe (B), which is connected with the inlet valves of the exhausting engine at the surface. This exhausting engine can be run direct by a steam engine or driven by belt power or otherwise, so that a small steam cylinder with piston speed run up to a high velocity would do the work required.

The piston of air discharge or exhausting engine when put in motion discharges or forces out the air through the outlet valve openings at the end of cylinder towards which the piston is travelling, the inlet valves at same end of cylinder remaining closed at that end of the cylinder from which the piston is travelling. Then is a vacuum formed, and on the inlet valves being opened the air rushes in from the large pipe (B) that is in communication with the valve chests of the atmospheric engine, the air on opposite side of piston at same time being forced out through the openings of the outlet valves.

The reciprocating motion of the piston in the discharge or exhausting cylinder (A) and the opening and closing of the inlet and outlet valves alternately so as to discharge the air that enters the cylinder from the large pipe (B) leading from top to bottom of mine, and into which the air from atmospheric engines exhaust, is the means of relieving that atmospheric pressure from alternate sides of the pistons of atmospheric cylinders, and the atmospheric air being alternately admitted to the opposite side of said pistons from which the air is relieved. The power or pressure thus exerted on the pistons of atmospheric engines is utilized for the working of one or several plunge-force or other pumps.

Assuming an exhausting engine of one hundred inches diameter of cylinder, with piston speed of four hundred feet per minute,

and vacuum at ten lbs. per square inch, the work done per minute would be equivalent to working a line of eighteen inch diameter plunge-pumps from a depth of four thousand feet, and delivering seven thousand seven hundred gallons of water per minute from the same depth.

A modification of the already described exhausting engine would be in inclosing the discharge valves from the exhausting cylinder in the same manner that the inlet valves would be arranged, and then in the union pipes connecting the exhausting cylinder (A) with the large pipe (B) leading down to the bottom of the mine. Then would be placed four valves arranged with levers and links to a common handle, so that when said handle was moved from one position to its opposite position that the exhausting engine could be transformed into a blowing engine, so that in case of foul air being in the shaft or mine, and men not able to go down the shaft, that by changing or reversing the handle alluded to that the piston of the exhausting cylinder would force fresh air from the sufrace into the mine, and then men could be lowered on a cage down the large pipe (B) connect-the exhausting cylinder with the several atmospheric cylinders.

There would also be valves conveniently situated down the mine on the large pipe (B) that could be opened either from the inside or outside so as to allow the men that are on the cage in the pipe to go off into the mine or to admit the men on the cage from the mine.

These valves could be opened also by the men working in the mine, so as to be able to have a supply of fresh air that would keep them living until they could be taken up by the cage travelling inside of the large pipe, that is when the engine at the surface was used as a blowing engine.

The PRESIDENT—I believe it will be found convenient to postpone discussion on this important paper. It is a very important matter to decide as to the value of hydraulic pressure where you have to raise it by means of steam engines, working the accumulators and such like, and requires a good deal of thought. I dare say, the paper, when we read it, will bring this clearly before us. There is one thing that the use of wire ropes is a very objectionable point—I mean for pumping rods. I can never get myself to think

that a good thing, because you have the wear and tear every stroke, the same as in winding a cage of coals from top to bottom. However, I should like to study the matter clearly before saying much about it. As to air-compressed engines, that is very different, and is also very exceptional, so far as we know, but we will be better able at next meeting, after we have had the paper before us, to discuss the point; and, in the meantime, I think you will agree that we ought to accord a hearty vote of thanks to Mr Barclay, who has taken the trouble of coming here, and laying his plans before us. (Cheers.)

BERRYMAN'S PATENT HEATER.

The PRESIDENT—While out at Niddrie to-day, we met Mr Wright, managing director of Joseph Wright & Co. (Limited), Tipton, Staffordshire, who is the patentee of a very excellent heating apparatus—Berryman's Patent Heating Apparatus—and the Council thought you might be pleased to see his model, if he would like to exhibit it. He kindly consented, and is prepared to give a few remarks on the patent heater. The apparatus, as he will tell you, effects a great saving in coals, inasmuch as the heat of the exhaust steam, which goes into the air in high pressure engines, is made to heat the feed water up to the boiling point, and thus effects a great saving.

Mr WRIGHT—The model I hold in my hand is of an apparatus brought to this country by our friends across the Atlantic. It is called Berryman's Patent Universal Expanding Tubular Feed Water Heater, and its object is two-fold—first of all to heat the feed water before entering the boiler, but that is a small matter, because the mere heating of water has been done in this country ever since we knew anything at all of engineering, and the greatest amount of saving effected by heating water to about 212 degrees is not more than 15 per cent. But we find by confining the water in this Heater under pressure for a given time, we not only heat it up to boiling point, but we absolutely precipitate all

carbonate of lime, animal and sewage matter, into the bottom of the Heater, and blow these away by the mud cock put on the Heater for that purpose, and we find by experience that by keeping this matter out of the boiler, and so keeping it clear of hard scurf, the further economy is over 10 per cent., making in all 25 per cent. of coals saved on the two operations, and there are cases in Edinburgh where the saving has been as much as 30, 40, and even 50 per cent.

In the case of collieries, where there are a number of engines, we take only the fan or other engines, and the whole of the steam of these engines is condensed and put back into the boilers. Consequently, about 80 per cent of these particular engines is saved so far as heating is concerned, for the elastic lesser force has done its work in these engines. The whole of the other engines in the establishment take the same advantage as the fan engine has taken for its own boiler power, making in all a saving over the whole of the engines equal to about 20 or 25 per cent., being 80 per cent. on the particular engines to which the heater is attached. That arises because a larger quantity of feed water requires to be heated than the particular engine uses for its own purposes, and there is almost five or six times as much available waste heat in the steam than is required to heat the water for its own boiler; and, as I have said, in collieries where there are a large number of engines we are well able to save up to 80 per cent. of the coals required for the engine to which the Heater is supplied, and in such cases we have no difficulty in saving the total outlay in eight, ten, or twelve months. The one you saw working at Niddrie Colliery to-day is one of the largest sizes but one which we make, and I believe it has given the satisfaction spoken of before we fixed it; and I feel sure those who saw it to-day would find something worth while considering for their own collieries. We are fixing some in Edinburgh, the largest in the kingdom, and the largest ever made, weighing 22 tons, and capable of heating and cleaning 6,000 gallons of feed water per hour, and not only heating it, but taking every particle of carbonate of lime and sewage matter out of it, so as to entirely prevent hard incrustation. These are at the North British Rubber Coy. Works here, where the boilers were very much

encrusted by hard water, and which we shall entirely remove. We have now about 600 of these heaters at work in this country, some of them at Mr Watson's Earnock Colliery, Hamilton, at the Marquis of Lothian's Collieries, New Battle, at Niddry, at Messrs John Elder & Co., Glasgow, and elsewhere. One colliery near Manchester is now fixing its No. 8, and in America, while we have been selling 500 or 600 in Great Britain, they have managed to dispose of over 7000, showing we do not get on quite so well here with new improvements as our friends over the water.

The operation of the heater is that the exhaust steam passes in here (shewing), and goes through the whole of the brass and copper tubes together, down here (shewing) and passes away into the air—if their is any to spare. Sometimes we have a valve on the exhaust-steam exit for the exhaust-steam, which acts as a vacuum valve, and sometimes a small vacuum is maintained by it. The outer water casing is made of great length, especially when the water is required to be cleaned, as it is absolutely necessary that it should be kept in the heater a long time in order that the carbonate of lime and sewage and other matter way be properly extracted before the water leaves the heater for the boilers. There is a tap with a long down pipe from the top of the heater. A glass of cleaned water drawn from this tap, and one from the tap on the bottom of the heater, will show the one water quite bright, while the other is quite the reverse; and a little nitric acid applied to both glasses of water will show that the carbonate of lime has been extracted from the one, but still remains in the other.

The PRESIDENT—I am quite sure you will have heard with much interest the remarks on this very simple apparatus, which I know does a good deal of what Mr Wright says, and is well worth your study. There have been many similar arrangements for heating the water. The new thing, however, is the deposition of the sediment, and if that is done it is of very great importance.

Mr M'CALLUM—When Mr Wright came to Niddrie Colliery and shewed this model of his I had very grave suspicions as to what he was saying about it. I felt inclined to turn my back upon him and say you are just like the rest of them that come with those patents which are generally found to be useless when

put to the test. But after hearing Mr Wright for a few minutes, as he explained the heater, I came to the conclusion that it was a good thing, and advised him to go to our Chairman and shew him the model. He did so, and although, I believe, our Chairman, like myself, was at first very doubtful as to whether it could accomplish all that Mr Wright said about it, thinking there was something in his explanation, he gave an order for one. I now find after having had the heater at work for nearly twelve months that it has given great satisfaction, so much so that we are fitting up a second one at another pit. We find the heat can be raised to 200 or 210 degrees Fahr., and we also derive another advantage from the use of this heater. The boilers at Niddrie Colliery are fed with water containing in solution a great deal of matter which was deposited in great quantities on the boilers, forming a hard crustation, but the amount of deposit is much reduced since the heater was put in operation. I have no hesitation in saying that in my opinion much money is uselessly expended in a Colliery where these heaters are not used.

The PRESIDENT—Our business is ended, and I have only to say that this meeting in Edinburgh has proved a much greater success than I at all had imagined. I think it must have convinced you all of the utility of these meetings and the utility of this Institute. I daresay few of us expected two years ago when this Institute was just in its beginnings that we could have got together here such a number of gentlemen connected with coal mining. I am sure it has struck me as something wonderful the number of known faces, all anxious to get knowledge on mining matters, and the result is very gratifying to me and the Council, who have had the hard work to do in connection with the meeting. It always shows to me more clearly the benefit of an Institute such as this. It brings us together to think and see and compare notes with each other, and perhaps by no other means could we have had the paper we have heard read to-day. First, you have come together to a new place and got a description of the haulage and the mode of working which is new to most of you, and next a very interesting account of the whole subject, the mode of working, and the very excellent machinery employed. I was particularly struck with a remark of one of your number—I see him

before me; he said, "There's no muckle wrang wi' this place!" (Laughter). We have seen many new things, and all of us have been improved by them, and I say it shows the benefit of such an Institute as this when we can meet together and get instruction in this way. Then, again, we have heard, what we could not have heard anywhere else, of a mode of lifting water which we will have time to think over and discuss. What a privilege it is to get such a matter brought before us and discussed. Then also we have seen Berryman's Heater. Mr Wright in doing good to himself has been doing good to us. He has brought this before a meeting of people who can appreciate it. The whole effect of it is that these meetings are very essential to the prosperity of the Institute, and although they involve a good deal of work to the Council, it is a pleasure to them to see you responding to their call in the way you have done. This has been the first of these meetings, and it has been so successful I believe you will all desire to have more of them.

VOTE OF THANKS TO THE PRESIDENT.

Mr J. S. DIXON—I beg to move a hearty vote of thanks to Mr Moore, our president. We all know the great interest he takes in the Institute, and the amount of good his presence does amongst us. He has also had a good deal of trouble in connection with the meeting to-day. I therefore beg you to give him a hearty vote of thanks. (Cheers.)

The PRESIDENT.—I am very much obliged to you, and anything I can do to you is very much at your service. The meeting here to-day will tend to the success of the Institute, and I am glad it has been so well attended. (Cheers.)

The proceedings then terminated.

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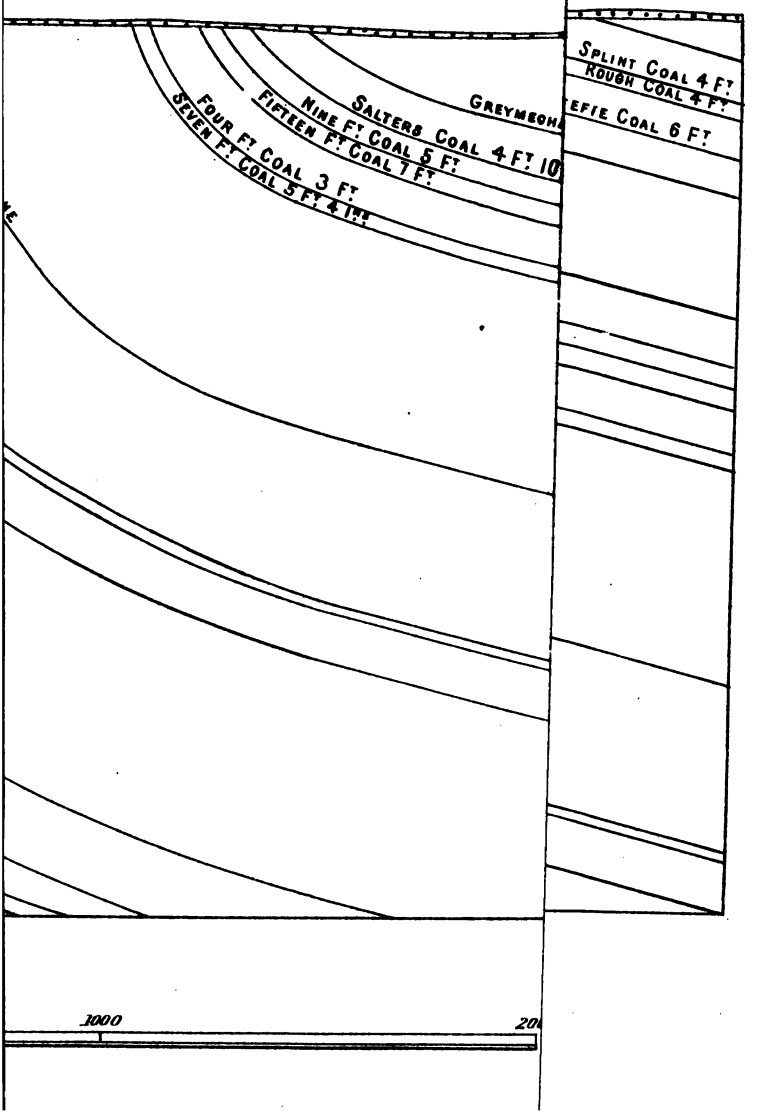
EDGE SEAMS OF NIDDRIE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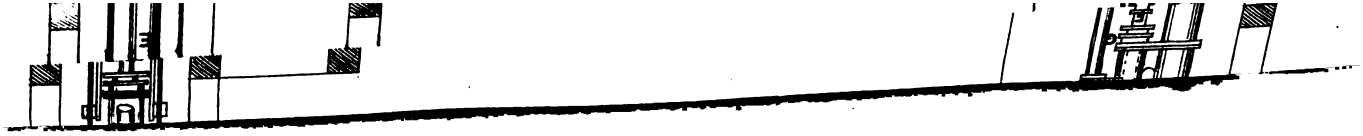

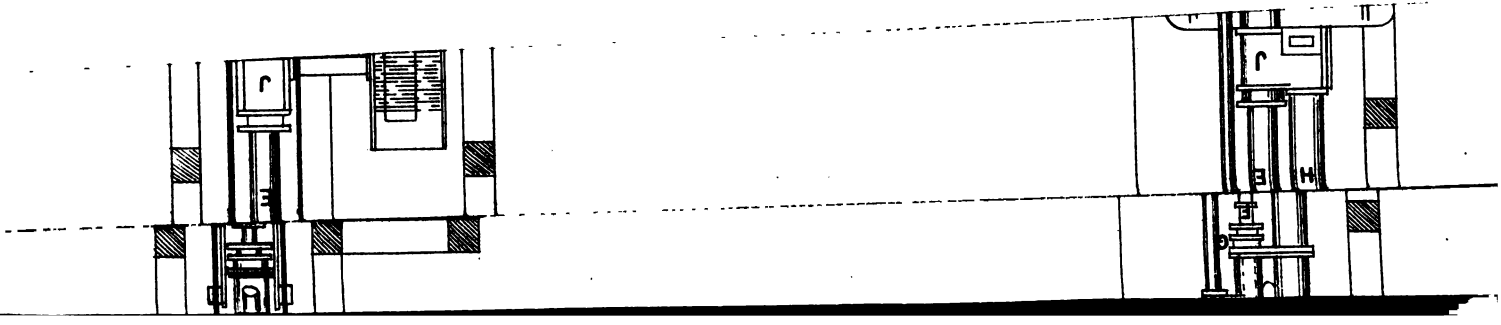

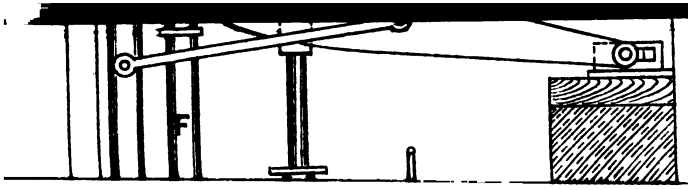

FIG 2.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING, 9th SEPT., 1880,

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON.

RALPH MOORE, Esq., President, in the Chair.

The SECRETARY read the minutes of the last meeting, which were approved of.

The following gentlemen were then balloted for, and admitted as Ordinary Members :—

JAMES P. W. WALKER, Civil Engineer, Dalmellington Iron Works, Ayr.
ROBERT HAMILTON, Mining Engineer, 175 Hope Street, Glasgow.
GEORGE M'CREATH, Mining Engineer, 95 Bath Street, Glasgow.
GEORGE BROWN, Colliery Manager, Longriggend, Airdrie.
JOHN ANDERSON, Colliery Manager, Shottstown, Penicuik.
JOHN ROBERTSON, Colliery Engineer, Lanemark, New Cumnock.
JAMES GAVIN, Colliery Manager, Carfin, Motherwell.
WALTER STIRLING, Colliery Manager, Rawyards, Airdrie,
ANDREW CROOKSTON, Colliery Manager, Kingseat Colliery, Dunfermline.
JAMES RUSSELL, Colliery Manager, Elgin and Wellwood Collieries, Dunfermline.
WILLIAM FRAZER, Mineral Manager, Uphall.
A. L. M'LATCHEY, Assistant Manager, Fordell Colliery, Fife.
JOHN AINSLEY, Engineer, Niddrie Colliery, Portobello.

Other eleven gentlemen were then nominated as Ordinary Members, and will be balloted for at the first meeting.

DISCUSSION ON MR WILSON'S PAPER ON THE DETECTION OF GASES IN MINES.

The PRESIDENT—The first business is to discuss the paper on the Detection of Gases in Mines. The principle of Mr Wilson's paper is that he attempts to detect, by the specific gravity of the atmosphere, whether it is explosive or not—that is to say, if it is lighter than common air it is explosive, and it will be told by his arrangement. It is not by any means new. I recollect Mr George Simpson (whom some of us know) proposed the same thing many years ago. At the same time, it is a very ingenious arrangement. Have you anything further to say, Mr Wilson, on the subject?

Mr WILSON—Since I read the paper, I have been trying the instrument to see what effect the pressure of the atmosphere would have upon it, and I find it is much more effective than it was originally supposed. In taking it down a pit, the ball rises an eighth of an inch for every 40 feet, and upon any alteration on the pressure of the atmosphere, it acts like a barometer, only quicker, and to a greater extent.

The PRESIDENT—And does that facilitate the action of the instrument?

Mr WILSON—I do not think it would be any disadvantage. Suppose this does occur—because I think it is a doubtful question what effect the pressure of the atmosphere has on the gases, and whether the gases are given off in proportion to the reduction of the pressure—in that case a sudden change of the pressure might be more quickly detected by this instrument than by the present barometer, and means used for having an increased ventilation in the case of a falling barometer, seeing the present is considered about two or three hours late. It does not matter whether the ball is filled on the surface or not. If it is hotter below, it expands and makes up the difference, but the balance would have to be adjusted wherever the instrument was to be placed.

Mr MACCREATH—I think it is of great importance to have

these matters brought before us. A number of the members very probably might not otherwise have had their attention called to the subject.

Mr RONALDSON—I am afraid, after what Mr Wilson has told us about the change upon the instrument through being lowered in the cage, that the effect of the variations of the barometer upon it will render its indications very uncertain below ground. If a difference of level of forty feet makes an eighth of an inch difference upon it, a rise or fall of an inch or even half-an-inch of the barometer would make the arm rise or fall to a considerable extent.

Mr ROBSON—I would like to know if Mr Wilson attaches greater importance to its power to detect the gas or to act as a substitute for the barometer. It is not quite clear how the one affects the other. The first thing was the detection of gases by the ball rising or falling, but now it is affected by the atmospheric pressure, and I think it has not been quite clearly brought out whether the instrument will still detect the gases in the way described in the paper.

Mr WILSON—Placed in a position between the intake and return air-way, where it could he adjusted to find out what change there had been in the atmosphere from the last inspection, the difference in the specific gravity of the air in the return air-way could be easily detected by it. Supposing an alteration takes place and the ball fell an inch and a quarter, it is just possible it is as dangerous whether it is by actual gas or a reduction of the pressure, and I think in that case its sensitiveness in connection with the pressure of the atmosphere is rather in its favour than against it, because the instruments we have at present are too late to be of so much service as they might be.

The PRESIDENT—I understand from what you said just now, that you don't propose it to be an instrument to be removed from one part to another, but to be fixed at a station.

Mr WILSON—Yes.

The PRESIDENT—And you expect that it will only be affected by the rise and fall of the barometer ?

Mr WILSON—Or by gases in the air.

The PRESIDENT—Yes, but the ball itself will be affected by the pressure of the atmosphere.

Mr WILSON—Yes.

The PRESIDENT—Will you require to set it afresh each morning, or how would you be able to tell whether it is the gases or the pressure of the atmosphere?

Mr WILSON—Suppose in between the intake and return airway, there are two doors. By opening the door communicating with the intake airway, it could be seen whether the pressure of the atmosphere had affected it anything from last inspection.

The PRESIDENT—What percentage do you think you could detect?

Mr WILSON—I have not really tried it for the lowest percentage, but in sharp fire-damp it fell an inch and a quarter, and I would suppose that it would be affected proportionately.

The PRESIDENT—Do you really suppose it would be any better than the safety lamp.

Mr WILSON—The difference between it and the safety lamp is this: It would warn people of the presence of fire-damp without anybody being actually near it by the ringing of the electric bell, and it might be beneficial in the case of accident, such as a fall in an air-course.

The PRESIDENT—What I was meaning was this: supposing I was going down in the morning and hearing the bell ringing, I could not depend upon its indications until I had made the test to see if it was correctly set. Is that so?

Mr WILSON—You would know something was wrong—you would not know what it was.

The PRESIDENT—Precisely; but if I went in and found the bell ringing, it might not be indicating fire-damp at all, and would not be to be depended on until I applied the test to see if your instrument was set properly.

Mr WILSON—That would depend wholly on the position it was expected to ring. If it was set to ring within the moving space for fire-damp then it would ring before fire-damp was visible; if outside, it is not likely a change of atmosphere would cause it to ring.

Mr SMART—Suppose you had your instrument set, and the

barometer was standing at 30 inches to-night, and it fell to 29 inches, would you expect to have a continuous ringing of the bell then ?

Mr WILSON—If the bell was placed within the range of that movement it certainly would be rung.

Mr SMART—Of course, we understand if the barometer affected the air above, it is sure to affect it below in the same ratio.

Mr WILSON—Quite the same. This instrument acts more particularly where the fire-damp is pure, where there is no air in it at all. Of course, the specific gravity is less in that case. In one experiment it was not known whether the mixture was fire-damp or choke-damp. The Davy lamp did not detect anything, and this instrument detected that the gas was lighter.

The PRESIDENT—If choke-damp, I am afraid it would need to be set again.

Mr WILSON—It was supposed to be choke-damp. It was not.

Mr SMART—It should have had an opposite tendency, for, of course, choke-damp is heavier than the air.

Mr WILSON—They fancied it was choke-damp, and it was lighter.

The PRESIDENT—Then it could not be.

Mr WILSON—No, it was not.

The PRESIDENT—I agree with Mr MacCreath that it is desireable we should know anything new. We are obliged to Mr Wilson for bringing the paper forward, in the hope that it will induce others to follow in the same direction. We stand very much in need of some remedy, for we have had two explosions within the last few weeks, killing over 200 people. I would not like to give any further opinion than I have done on the instrument. Mr Ansell has a very similar thing, made in the form of an aneroid, but the objection to it is that the temperature affects it. It is a very pretty thing, but I don't think it is of any practical use. There was a gentleman called on me from Belfast who has a scheme. His was by certain chemicals to make the gases visible under certain pressures, and the speed with which the gases passed through a small jet indicated the quantity of hydrogen in it. Another very pretty thing is Mr Liveing's, which has two electric points. One is burning in *vacuo*, the other open to

the atmosphere of the mine. If the atmosphere contains fire-damp, a light exposed to it is brighter than the other in proportion to the quantity of gas which it contains. I dare say there may be others that I have no recollection of just now, but we have never found anything really very useful yet. I think we should give Mr Wilson a vote of thanks for the trouble he has taken to illustrate the matter before us. The point, which is really of great importance—the detection of gases in mines—should be continually kept in our view.

Mr WILSON—I thank you, gentlemen, for the vote of thanks.

THE LOTHIAN COAL FIELD.

The PRESIDENT—The next paper for discussion is that of Mr M'Callum on the Lothian Coal Field. I do not know that there is much to discuss in it. The paper is very clearly written and shows the various seams which are to be found there in such a short distance, owing to the inclination of the strata and the mode of working them. If any of the gentlemen present have any remarks to make, we will be very glad to hear them.

Mr SMART—I understand, looking at the section, that the upper coals are nearly flat, but the further you go down you get them steeper.

The PRESIDENT—Yes. They call the upper coals the "flat coals." Of course, you are aware they are only "on edge" in Niddrie and the western outcrop. On the eastern side of the basin they are comparatively flat.

The PRESIDENT—There are many points which would bear some remarks. I daresay many of you saw the system of pumping by the engine underground.

Mr HASTIE—It worked very satisfactorily so far as I saw.

Mr T. M. GRANT (Kilmarnock)—I also think it worked very well. It was working satisfactorily when I saw it, but I should have liked to see it working at a greater speed. They made

the excuse that there was no water. It was only going at two strokes a minute, but to test an engine of that kind is to see it at eight or nine; otherwise it was working as well as any engine that I ever saw.

The PRESIDENT—Mr M'Callum also notices the signals which were simple and very effective. You would see them at the entrance to each road. We had a paper by Mr Smith some time ago explaining these signals. As to the whole arrangement for working edge coal, they are very different from flat coal workings. I daresay all of you practical gentlemen will be aware that it is not possible to work an edge coal so cheaply as a flat one. Still, it is very well we should see those things, and beyond saying we are very much obliged to Mr M'Callum, I think there is nothing more to say on the subject.

MR BARCLAY'S PAPER ON "A HYDRAULIC PUMPING SYSTEM."

The PRESIDENT—The next paper before us is rather an ambitious one. It is brought before us by Mr Barclay, an engineer, a nephew, I believe, of Mr Andrew Barclay, of Kilmarnock, whom we all know. He had been in California and Nevada, where they require to pump from very deep mines, and he has brought out this system before us. I hope you have all studied the paper well, because I think it is a subject on which we should have a good discussion. I am sorry to hear that he is not here; in fact, he is not in the country, so we are in the unenviable position of criticising his work in his absence. However, Mr Grant may perhaps be able to reply to any points.

Mr T. M. GRANT—Yes, the most of the points.

The PRESIDENT—The object of Mr Barclay appears to be to lessen the weight of pump-rods, and he does this by having an additional column of pipes and plungers for causing the descent of the ram which raises the water, instead of having the excessive heavy weight of pump-rods as in Cornish engines. He does not

propose to have any valves in this extra column of pipes, but lifts the ram and the weight of water in the forcing pipes by means of two wire ropes attached to the beam of the engine. In this way he thinks there will be much less weight than in the ordinary system; and, of course, it would be possible to drive the engine more strokes per minute. The disadvantages of the system appear to be that there will be the friction of three rams in place of one—the ram at the surface for actuating the forcing column, the one at the plunger, and the plunger itself. If the pressure column be large there would be a great weight of water for the two ropes to lift; if it be small, there would be less, but there would be more pressure applied at the engine and the difficulty of keeping joints. Ropes have never been satisfactorily applied for pump-rods, and, I think, are objectionable. Mr Barclay, however, might use wooden or iron rods, and still have less weight. I fail to see that this system would be so advantageous a mode of using hydraulic pressure for pumping water as any of the hydraulic engines which are used for that purpose; for, although it is necessary to use valves, pump-rods are dispensed with altogether and there is much less complication. I think a system similar to this was patented by Mr Darlington some years ago.

Mr ROBSON—If pump-rods were substituted for the wire-ropes proposed by Mr Barclay, but considered objectionable, I would be afraid that where there were, say, three plungers, the rods would become nearly as heavy as in the present arrangement. They would be at least half as heavy, as they must necessarily be strong at the top lift, although of less strength for the lower lifts.

The PRESIDENT—Perhaps, Mr Grant, there may have been some of the points I have not described properly, or the object of them.

Mr T. M. GRANT—I can only say Mr Barclay asked me to come here because of his having to leave for San Francisco some three or four weeks ago. As far as the atmospheric arrangement is concerned, I have not looked into it much, but from what I have read of it I have not formed a very high opinion of it. In his hydraulic system I think there are some good points. The great objection that has been made against it is in the use of steel ropes. Whether you could get anything better I do not know

but certainly you can get a greater tensile strength per square inch from a steel rope than you can get from any other material, and as the ropes do not pass over pulleys, where is the objection? Whether a rope corrodes faster than a solid rod of iron or steel, I believe some of you gentlemen here will know; but failing steel ropes, steel rods could be used. There are certain parts of the arrangement that seem to me to be as straightforward to the work as possible. The water does not pass through valves or quick bends, as in other hydraulic arrangements in use. Of course, in this country, where pits are not so deep, you can balance your rods by properly proportioning the weight of them to the work done, but you must have counterbalances where pits are a little over one hundred fathoms deep. For pits here, I do not think Mr Barclay's arrangement any better than what we have at present; but for shafts from four to six hundred fathoms there must be something invented in lieu of wood rods, because they get to be so enormously heavy, and so many balances are required, it is scarcely possible at these depths to keep the pumping gear in repair at all.

The PRESIDENT.—Is there anything in the friction of the stuffing boxes? You see you have all the chances of leakage and friction; you have three plungers for one. What I mean is, if you had only one set of pumps, then you would have three plungers instead of one.

Mr T. M. GRANT—Exactly.

The PRESIDENT—If two sets of pumps, then you would have five plungers instead of two, the top plunger being of an area equal to the other two. For every additional set there must be additional area in the plunger at the surface.

Mr T. M. GRANT—You must have more power at the top, the more pumps you have, but it is not necessary that the area of this should be the combined area of all the sets of pumps. The friction of the stuffing boxes is not nearly so much as the friction of rods and balance beams.

Mr RONALDSON—I was just thinking this afternoon, but I have not worked the thing out at all, of a method to do away with these objectional wire ropes, and work the whole thing by means of hydraulic arrangements. That was to have another

small column of pipes similar to the column (D) shewn on plate V., carried from the surface to the bottom of the shaft. Then, by some means attach to the beam of the engine an inserted plunger connected with this column of pipes, so that, on the upstroke, pressure is transmitted through the small pipe to a plunger connected through a stuffing box to the bottom of each of the plungers (E). These additional plungers would have a suction sufficient with the pressure upon them to raise the plungers (E). Of course this system would involve having another plunger at each set, as well as the one at the surface, and there would be the friction of all these stuffing boxes to encounter. I do not know how it would work, but the idea occurred to me that it might do away with rods of any description.

Mr LAIRD.—I never saw the paper before yesterday, but I would ask what was the proportion of the work expended on the pumping of this system to the pumping of our present system?

The PRESIDENT—There is no saving of work, that is to say, you have the water to raise, whether you raise it by means of water pressure or by means of rods. There will be a slight loss owing to the friction of the stuffing boxes and the water, but the object is to do away with the immense weight on the beam of the engine, amounting, in some cases, to 400 tons, including balance beams in the pit and on the surface. The difficulty of starting and stopping such an immense dead weight as this is very great, and few strokes can be made in a minute, so this scheme is proposed by which you would have less weight affecting the movements of the engine.

Mr T. M. GRANT—The only point is the rods, but Mr Barclay has made them do, and he has taken ropes as the lightest material with the greatest relative strength to overcome the difficulty as to balancing. He has only a plunger and the weight of the water on that column to balance.

The PRESIDENT—On each column, and that must be a large column, and you get the friction and the water.

Mr T. M. GRANT—That friction would be less than the present, through the use of balancing beams, because these take up more than any friction from any stuffing box you could make. Of

course, the relative cost is just as expensive on one pump as on the present system. There is no saving as far as regards that.

The PRESIDENT—But rather the reverse. That is dependent on whether the friction of the balancing beams is greater than the friction through the stuffing box, not to speak of the difficulty of keeping a stuffing box upside down tight. Then, I suppose, on that part you do not feel inclined to say any more. The next part of the paper is also a scheme for dispensing with pump-rods, but in this case Mr Barclay proposes to use air instead of water as the moving power. He places an engine on the surface to work a large air-pump, and by means of the vacuum so formed, to work an engine at the bottom of the pit, or part way down, which raises water in the ordinary way. There is not the same theoretical loss in creating a vacuum as there is in compressing air, but two engines with twice the friction are required to do the work of one, with this addition, that owing to the small pressure the underground engine must be very much larger than the steam engine. We all know the difficulty in keeping an air-joint tight, and in pit work I suspect it would be still more difficult. I cannot see that the system would be at all workable, and certainly it would be more expensive than any other which could be adopted.

Mr MACCREATH—I agree that it is not a mode that is likely to be found advantageous in working.

Mr RONALDSON—At the bottom of p. 86 and top of p. 87 in his description of his first system he condemns the placing of pumping machinery in or at the bottom of the shaft, but he seems to have forgotten, in describing his second arrangement, what he says here, because he has fallen into the very error he has spoken against in the first part.

Mr T. M. GRANT—Of course, he means the pumps being at the side of the pit.

Mr RONALDSON—He does not refer merely to the pumps themselves, but I think, as our President has said, it is a very objectionable system to work with such a low pressure, which requires very large cylinders, and to have such a multiplicity of the engines themselves. Mr Barclay gives an instance at the bottom of p. 91 of what an exhausting engine would do. He makes it

raise 7,700 gallons per minute. That is an enormous quantity of water. I find it would take an 18-inch pump with a 12-feet stroke to go at over 58 strokes per minute to pump that quantity, but I suppose he has made an arithmetical mistake by adding an additional 0.

Mr ROBSON—I think it should be read 7,700 lbs. of water.

Mr RONALDSON—Yes, that would be about it.

The PRESIDENT—I think we ought to have from the gentlemen some remarks on this paper. It is very necessary that an Institute of this kind should express an opinion on papers which have been submitted to it, and especially on a revolutionary proposal (if I may call it) like this. The real idea, so far as I can see, is that Mr Barclay would be able to make a rotary engine go very quickly on the surface to form the vacuum necessary, and so be able to pump it by means of these large air engines at the bottom. Suppose he could get a very perfect engine, with a surface condenser, he could perhaps have a horse power for 2½ lbs. of coal per hour. In doing that he could afford to lose other 2½ and still be a gainer, for I am afraid very few of the pumping engines hereabout work with less than 15 or 20 lbs. of coal per horse power per hour.

Mr T. M. GRANT—I must say I agree with most of your remarks as far as the engine is concerned. The idea Mr Barclay has had in view was to carry out a French patent of Zulma Blanchet's, the Director-General of Mines at Epinac Saone et Loire, for winding the coals,—winding by an exhaust engine at the top, and a piston working into a tube and lifting six tubs at a time. But it seems to me a small pressure—10 lbs. to the square inch. Everything would be so cumbrous that really it could not be practicable. I think more of his hydraulic arrangement than I do of this.

The PRESIDENT—There is in France an arrangement such as Mr Grant has explained. It is a very deep pit, and they have two tubes, about 6 ft. in diameter, into each of which they put a piston, and attached to the piston is the tub of coals. They extract the air out of the tube and so raise the piston and coals, dispensing with ropes, and, as they say, economically. I rather think they have no rope for balancing the pistons.

Mr GRANT—No, they have no rope. They say it works well,

and it is in practical operation. It is a very safe mode of working. There can never be over-winding, it would stop before it goes to the bottom. There are four pistons, and all the four would have to break before it collapsed. It is a malleable iron tube, three-eighths of an inch thick, stayed in the outside, and the pistons are formed of hemp packing, I think. It raises six tubs of coal at a time, and there are three stages at which they take off the coal—three at the top and bottom—and they have just the common catches you have here for resting the cages on. It is worked by a system of valves at the top and bottom. At the top and bottom they put the piston in equilibrium when stopping, and open the valve and let the pressure on.

The PRESIDENT—I think the meeting has rather to express its regret that Mr Barclay is not here, and also that we have been obliged to say some things in his absence which are not favourable to his invention; but having the interest of the Institute at heart, and having regard to our individual opinions, I do not see why we should hesitate to express them. Had Mr Barclay been here, we would have been glad to alter or abate anything we have said, but as he is absent we cannot do other than simply say we have done what we thought was right, and give him a vote of thanks for his kindness and great trouble in preparing this paper and bringing it before us.

BERRYMAN'S PATENT HEATER.

The PRESIDENT—The next subject for discussion is Berryman's Water Heater.

Mr GILCHRIST—I daresay some of you may know there is one of Berryman's Water Heaters working at Earnock Colliery. The heater is so constructed that the pump which feeds the boilers forces cold water into and through the heater, at the same time forcing an equivalent quantity of heated water into the boilers. I cannot say much for the saving, from the simple fact that we started with it; but I can tell you that a short time after the heater had been in use, one of the brass tubes burst, and during

the time the heater was off we burned 7 tons of coals in the twenty-four hours, and while it was working we only used four tons of coal per day. We have a thermometer attached to the pipes near the boilers, about 30 ft. from the heater, and at that point I have seen it register 206 degrees.

The regular temperature is 180 degrees, but the engine to which it is connected is not fully employed, and if it were, it is possible the temperature would rise to 212 degrees.

I may also state that a considerable amount of sediment collects in the water heater, and we have to clean that out occasionally. There is no doubt it is much better cleaning it out there than if it had got into the boilers.

The PRESIDENT—And that is a thing that does not require any great attention.

Mr GILCHRIST—No; it only requires cleaning every six weeks or two months.

Mr MACCREATH—I think it is quite impossible there can be so much saving of dross. It could only be 16 per cent.

Mr GRANT—Mr Wright says in his paper 50 and 80 per cent.

The PRESIDENT—I expect that will be where he applies it to four or five engines and thereby saves more of the heat.

Mr GRANT—He could not get it above boiling point.

The PRESIDENT—No; but supposing that there are three engines at work, and he uses the exhaust steam of one of them, he will be able to heat as much water as all three engines require. Have you any idea of the cost?

Mr GILCHRIST—It cost £250. It is rather expensive, but I think it has paid itself already. Its dimensions are as follows: 15 feet high by 4½ in diameter, and there are 828 feet of inch and three-quarter brass tubes in it. The steam passes through the brass tubes, and the water rises round about, then the steam inlet and outlet are 12 inches diameter.

The PRESIDENT—Did you ever try if there was any back pressure on the engine?

Mr GILCHRIST—No; the exhaust pipes from the engine to the heater are 10 inches diameter. When it was first started, both of the winding engines were connected with it (the exhaust pipes from the other engine were 6 inches diameter); but I thought the ex-

haust steam of the one was working against the other, so I cut off the smallest, so that at present it has everything in its favour.

The PRESIDENT—It will be practically this—if there is more steam than can be taken up, there will more exhaust into the air; so that there is no benefit obtained by putting in more steam than is necessary.

Mr GILCHRIST—Yes; it can only absorb a certain quantity.

Mr T. M. GRANT—Water heaters have been upon winding engines since ever I remember. There are various forms of them. The great advantage of Berryman's is that he does not let the steam come in contact with the water. Of course that has been done over and over again, but in a different form. There is no doubt a great saving wherever it is applied. At the same time, it is not better than any tubular heaters that do not let the steam come in contact with the water. The saving can never be more in one engine than 16 per cent.

The PRESIDENT—I think what Mr Wright said was this: If I have four or five condensing engines working, I would take one of those condensing engines and make it a high pressure one, and heat the water for supplying all the boilers and thereby save 50 per cent. There was a saving of the water being put in clean and a saving in heat.

Mr BAIRD—Does the engine you have got with the heater work as effectively as the one not connected?

The PRESIDENT—Is there any back pressure I suppose you mean?

Mr BAIRD—That is what I want to know.

Mr GILCHRIST—We have never taken diagrams of the engine; but my opinion is that we have no back pressure.

Mr GRANT—There can be no back pressure.

Mr MACCREATH—I see Mr Wright mentions the quantities in his paper. He cannot get more than 15 per cent.

The PRESIDENT—He says here very distinctly (reads). He says there is 15 per cent. of a possible saving and 10 per cent. from the clean water.

Mr GRANT—Of course you cannot expect to take out all the impurities. It is only the impurities that fall out of the water in boiling.

The PRESIDENT—The precipitation.

Mr GRANT—Quite so.

Mr MACCREATH—That has been done in a rough manner for a long time.

The PRESIDENT—Yes, but I think the Council did wisely in bringing this before your notice. I do not know anything more neglected than the steam power we use in our collieries here. To my thinking it is perfectly absurd to see our large engines, our high-pressure engines going uncovered—our boiler tops uncovered, cylinders uncovered, pipes uncovered—the steam, without the least attempt at expansion, discharged at from 300 degrees out into the atmosphere. It seems to me a point we really ought to attend to. Berryman's Heater is taking a small advantage of it, but not to the full extent. Why should not we have more expansion, raise our steam pressure higher, not less than 60 lbs. to the square inch? Why should not we have condensers on our engines where there is sufficient water? I believe it would tend in two ways to make our machinery wear better, and make a smoother working engine. You would see at Niddrie they worked with condensing engines, and they worked very smoothly indeed. I know at this moment there are a pair of winding engines where they are putting up surface condensers, the air pump being worked directly by the engine. Then the covering of boilers, I think there is great room for improvement in that direction. We have put up some good machinery, and it is a pity to see it marred for want of a little attention to these details. I hope, therefore, not only heaters but also condensers and proper arrangements for keeping the heat in will be adopted, because the steam engine is just a heat engine. I would recommend some of you gentlemen to see the care taken in Cornish pumping engines to keep in the heat.

REID'S PATENT SAFETY CAGE AND DETACHING HOOK.

MR HUGH STRAIN, Jun., read a short paper on the above apparatus, in which he gave his experience of it after being over two years in operation on one of Messrs Ferrier & Strain's pits at Airdrie.

The patentee thus describes the apparatus which is illustrated on Plate VII. :—

"The said Drawing illustrates in elevation a mine cage A, having my improvements combined therewith. The slides in the shaft, between which the said cage travels, are marked B, and the winding rope is marked C; the chain which connects the said rope to the cage is marked D. This chain is connected to the cage A by its lower link *d* passing through a hole in the piece *a* at the upper part of the top framing of the cage, which is supported upon the shoulder at d^2 of the said lower link *d*. To the said link *d* is connected a weight E. Upon the said lower link is a pin *e*, projecting therefrom and engaging in slots *f* formed at the inner ends of the gripping jaws or prongs F, capable of turning upon pins f^1 upon the top framing of the cage, and terminating in points or claws which are in close proximity to the guides B when the parts are in their normal position. The tendency of the weight E is to fall, but this tendency is overcome when the connection of the rope C with the Cage A is intact by the pull of the rope and the weight of the cage.

Should the rope C or the chain D break, the weight E will descend (the link *d* being so shaped as to allow of this movement), and urge downwards the inner ends of the jaws or prongs F, so that their outer pointed or claw ends are forced upwards and outwards into the position indicated by the dot and pick lines, the said points or claws gripping or entering the substance of the guides B, and the cage is thereby held suspended in the shaft.

The chain D is made in two parts, connected together by the link *g*, into the slot or opening of which enter the inner ends of short levers *h*, *h*, turning upon pins h^1, h^1, passing through the link *i*, and through the said levers, the outer ends or tails of the said levers projecting outward from the side of the said link *i*. The link *g* rests upon the inner ends of theses levers, which levers so bear upon each other, or it may be they bear upon stops on the link *i*, that the said inner ends will not yield downward, and the attachment of the cage to the rope is by them maintained.

A ring or stop J is fixed near the upper part of the slides B, that is to say, at a height which will only be attained by that part of the chain D at which the said levers *h*, *h*, are situated

when the cage reaches an undue elevation, and is in danger of being overwound. The rope C passes through this ring, which is of such inner diameter that when the cage is being overwound the tails of the levers *h*, *h*, come into contact therewith, and are depressed thereby into the position indicated by the dot and pick lines, their inner ends rising out of the slot in the link *g*, whereby the lower part of the chain D and the cage A, being no longer supported by the said inner ends of the levers *h*, *h*, are detached from the upper part of the chain D and the rope C, and fall therefrom, the fall of the cage down the shaft being prevented by the claws F being forced into the guides B by the action of the weight E, as herein-before described.

The buffers *k* are provided for additional security, so that should the cage by any accident not be disengaged when the levers *h* are depressed, its disengagement will be effected by the said buffers coming against the ring J."

Mr Strain explained that at the connection of the chain to the cage there is a box fitted with an india-rubber ring 4"·dia. and 6" long, similar to the drawbar of a railway wagon, and on this box the whole weight of the cage is suspended, giving a fine elastic motion and resulting in less wear and tear to the cage arms and joints. During the time which the patent cage had been in use, it had worn out three ordinary cages used in the other winding division of the shaft. Beyond experiments which were satisfactory there had only been one case where the apparatus was brought into play when the cage with its load of 16 cwts. was overwound, and it remained fast within two inches of the point where it was detached. The cage can be put into working order within fifteen minutes after being disengaged. There have been no extraordinary repairs. He stated that the weight of the cage with its load did not in any way tend to disengage the hook; on the contrary, the greater the load the less likely was the hook to become disconnected. It is necessary that the slides be strong and well supported by buntons, in order to withstand the shock and to sustain the weight of the cage with its load in the event of an accident taking place. In Mr Strain's opinion it is impossible for the apparatus to fail in its action, even although the rope should break close to the drum while

the cage is descending and has reached mid-shaft. He stated that it is the most inexpensive patent cage that has yet been made, and thoroughly recommends it as possessing all the advantages which the patentee claims, and offered to show the apparatus to any members of the Institute desirous of seeing it at work.

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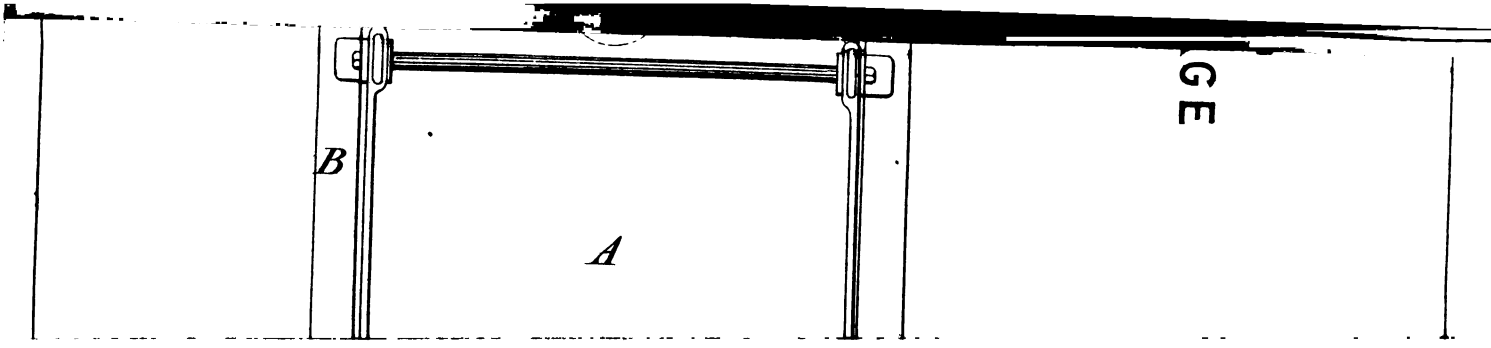
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THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING, 14th OCT., 1880,

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON.

RALPH MOORE, Esq., President, in the Chair.

THE Secretary read the minutes of the last meeting, which were approved of.

The following gentlemen were then balloted for, and admitted as Ordinary Members:—

WILLIAM PARIS BARCLAY, Mining Engineer, San Francisco.
ANDREW M'LEAN, Coalmaster, Lesmahagow.
ANDREW LAW, Coalmaster, Bishopbriggs.
ARCHIBALD GARDINER, Colliery Manager, Neilston Colliery, Kilsyth.
JAMES WYPER, Colliery Manager, Mauldslie Colliery, Carluke.
JAMES WILSON, Colliery Manager, Woodend Colliery, Armadale, Bathgate.
DOUGLAS JACKSON, Colliery Manager, Salisburgh Colliery, Holytown.
JOHN HUNTER, Manager, Woodend Colliery, Armadale, Bathgate.
ALEX. M'D. THOMSON, Inspector of Collieries for Wishaw Estate, Bank Cottage, Wishaw.
JOHN HARVEY CAIRNS, Under Manager, Dunmore Colliery, Bannockburn.
JOHN PHILIPS, Oversman, Braidwood Colliery, Carluke.

Other sixteen gentlemen were then nominated as Ordinary Members, and will be balloted for at the first meeting.

The PRESIDENT—According to form, the discussion of Mr Strain's paper should take place, but as Mr Strain has written that he cannot be here to-night, the secretary will read a paper on

FIFE SYSTEM OF CUT-CHAIN HAULAGE ON INCLINES,

By MR ROBERT ANDREW.

IT was suggested to the writer that a short description of this mode of haulage, which is said to be peculiar to Fife, might be both interesting and useful to those members of the Institute who may not have had an opportunity of seeing it at work. A great many of the collieries in Fife have steep workings, some of them having an inclination of 1 in 3 and 1 in 4. It is only where the inclination is about from 1 in 3 to 1 in 6 that "cut-chain inclines" can be wrought advantageously. Perhaps this is the reason why this mode of haulage is peculiar to Fife,—as it is generally the case that where a particular system is most required, there you will be almost sure to find it.

A reference to the sketch plan (Plate VIII., fig. 1) will show the general arrangements. Where the system is employed, the winning place or heading, which is to be the inclined plane, is driven direct to the "rise;" and the roads for the ordinary walls, branched off every 15 yards, are carried level course to the faces. The incline is laid with a double line of rails. At each branch there is a platform, consisting of two cast-iron plates, each 3 feet square, to turn the tubs upon; and there are four movable rails for joining the lines on the incline when required. The system admits of working not only from the top, but by an arrangement of "cuts" in the chain opposite the branches, tubs are taken from intermediate points.

A main chain reaching from the bottom B to the top, and around the wheel to W, is required to run the tubs from the top of the incline in the ordinary way. In addition to the main chain, short or "cut" chains are required between the top and the different branches. Thus, on the sketch there is shown a cut-chain from W to T, another from T to N, and a third from N to D. When tubs are being run from the top of the incline the cut

chains lie between the rails. There is a link (fig 3 and 4) at each end of the main chain, and also at the lower end of each cut-chain. At the upper end of the cut-chains there is a hook, shown in fig. 2. When tubs are to be run from the branch T, the hook of the cut-chain is attached to the link of the main chain at W, and the link upon the lower end of the chain is connected to the draw-bar of the tub to be run down. The main chain being connected to this cut may be said to be whole from B up to the top, around the wheel, and down to T. When the loaded tub is put over at T, which is done after lifting the portable rails on the incline, and runs down to the bottom B, the empty tub is being taken up from B to the plates at T. It is necessary that 2 or 4 runs should be made from each branch at a time, as if only 1 or 3 are made, the cuts cannot be put together to allow the next branch to run at N, unless the "cut" be put across to the other side of the incline to be connected; but this is easily performed, if the cuts are all kept on one side. Owing to a double roadway being required, often necessitating a line of props between the roads, the cut-chains cannot be thrown easily across from one side to the other. The same operation is required when running from other branches; thus, when the downmost branch, D, is to run, the cut from N to D is attached to the cut above it, and so with all the others, and in this way access in haulage is had from all the branches on the incline. It may be mentioned that, practically, the greatest distance which will work effectively at an inclination of 1 in 4 is from 60 to 70 yards. When the heading face extends over that distance, it becomes necessary to set off to the right or left, as is most convenient for siding accommodation, and drive another incline as at S. When there is a second incline, as at S, above the other, two tubs at a time can be run from W to B to supply the incline S.

In order to regulate the speed of the tubs, a friction strap is fitted upon the wheel, and a wire attached to the handle is carried down the incline to the lowest branch, D, so that after putting over a tub the person in charge of it can stop it, or run it slowly, by pulling the wire. It will be seen that this mode of haulage, when properly arranged in steep workings, does away with a great deal of laborious work in drawing on slope roads,

which, otherwise, would have to be done; and it reduces the whole drawing to be done on level roads. It is not very expensive in its application.

The PRESIDENT—It is not proposed to have the discussion on this paper to-night. The author will be present at next meeting, and it will be discussed then.

NOTES ON ACCIDENTS BY FALLS OF ROOF AND SIDES.

BY J. T. ROBSON.

THIS subject is of such vital importance that no apology appears necessary in bringing it before the notice of the Institute. The writer is of opinion that, although accidents from falls will always take place, if more extended and precautionary measures were taken to guard against them, many of the accidents which now happen would be prevented. With these premises, it is proposed to consider how far it is possible to reduce the number of fatalities by falls of roof and sides. In doing so, it will serve the purpose sufficiently to deal with the subject in a general sense, and to confine the remarks to a short description of the various conditions under which "falls" occur; the means taken for the prevention of accidents arising therefrom; and then to make suggestions for improvement.

Falls occur under, at least, all of the following conditions:—

(1.) *Where no danger is apprehended, and no means taken to guard against it.*

There are some roofs which in general are very strong, and consequently very unlikely to fall. With a roof of this description the tendency is to consider the working a safe one, so far as falls of roof are concerned. This idea of safety becomes through time more and more impressed on the minds of those persons interested in the working, and continues until at last some abnormal condition of the roof is suddenly met with, and a fall occurs where no means have been taken to prevent it. These

dangerous places in the roof, consisting of slips, local weaknesses, and slippery partings,—even when carefully inspected by competent persons,—are not always observed before the accident; indeed, in many cases there is not the slightest indication of anything being different from the roof which was previously worked under with safety. This being so, some additional measures should be provided, sufficient to prevent accidents from the causes enumerated.

Again, in some cases the mineral worked is of so strong a nature that great effort is required to force it down after it is undermined; in others, the roof parting is so bad (adhesive) that the coal is with difficulty got down. In these cases it is almost an invariable rule for the miners to deem the supporting of the coal, during the operation of "holing," unnecessary. Now and then, however, defects in the structure and cohesion of the coal occur, or the roof parting suddenly changes—occurrences often difficult and sometimes impossible to detect; and it often happens that the coal falls by its own gravity before the operation of "holing," or the means considered necessary to force it down, are completed. This fact appears to point to the absolute necessity of using the precautionary measure of spragging while the coal or other mineral is being holed or otherwise prepared for being taken down.

(2.) *Where no danger is apparent, but still some precautionary means are taken to guard against unseen dangers.*

In many mines, although there is no apparent danger, means to a limited extent are employed with the object of guarding against defects which occasionally occur. Still, very many accidents take place under these conditions. For example, falls occur between the coal face and the last prop or props when the distance is too great; the props apparently being set up more for the support of the roof when the place shall have become a drawing road than for the support of the colliers' working place. Falls also occur where the props are too sparsely put up, when the falls frequently break down or thrust out the props within the limits of the fall. A great many happen at the face of long-wall workings between the last row of props, or the buildings, and the coal face. When an accident occurs under any of these

conditions it is a proof that the means taken to prevent it were insufficient; and it is a reasonable inference that a more unrestricted method of guarding against the danger might have prevented the accident. The experience thus gained clearly shows that the remedy for this state of matters ought to be sought in the enlargement of the system pursued, so that the means shall at all times be adequate to prevent these accidents.

(3.) Where danger is suspected but not imminent, and the means about to be taken are delayed too long.

Accidents under this condition are of very frequent occurrence. Amongst the common causes may be mentioned the neglect of colliers to set up props as they work off the coal, preferring to leave that part of their work until it is more convenient; perhaps until they get their day's work of coal all filled up. The remark made by a collier to his companion, or in answer to advice, that he will put up a tree when he gets his hutch filled, is of every day occurrence, and almost every day, at either one place or another, the man who makes this remark delays too long to put up the prop, and the stone falls. Miners, as a class, are not exempt any more than others from this habit of putting off; and while a small portion of them act promptly in this matter, it is greatly to be feared that, if left to their discretion, the larger number will still continue, for the sake of their convenience, to run the risk.

Obviously, what is required is never to delay for a moment the necessary steps to make a place secure; and, in order that this may be done, it becomes a matter of absolute necessity that suitable materials for securing the roof and sides should be constantly available at the places where they are required, and that the discipline of the mine be such that no person shall continue in any place after danger is suspected unless he be a skilled person and employed to remove the danger. It appears that much good would result by the "competent persons" never leaving a place where danger has been detected until it is made secure.

(4.) Where danger is detected, but the means taken to avert the danger prove to be insufficient.

When an accident occurs under this condition—and many do—it cannot reasonably be held that all was done that was necessary, although it may only become apparent after the accident that

more measures were required to prevent it. It seems that the matter should be looked upon in a different light than is customary; because, if an accident has happened, another may happen under similar conditions. It therefore becomes a matter of necessity to consider carefully the exact circumstances under which these accidents occur, with a view to the adoption of a system which shall, as far as practicable, be sufficient to prevent accidents by falls which possibly may occur under this head.

(5.) Where danger is imminent, and accidents happen while removing the cause.

This apparently requires that more care should be taken in the selection of men to remove causes of danger in the roofs, and that all repairs be made under the supervision of thoroughly competent persons. Skilled men are more likely to proceed cautiously, and to keep themselves secure when repairing dangerous places.

(6.) While removing supports put up in the course of working to secure the roof after they are no longer required.

This cause of danger also points out the necessity for the utmost care on the part of those employed in the highly dangerous, yet reasonable and necessary operation of drawing out the props from the exhausted portions of the workings. None but the most active and cautious men should be employed, and only one man at a time should be actually engaged in knocking out props in a place where the timber is being withdrawn. It is often necessary, after the rails are removed and before beginning to draw the props, to set up additional props in certain positions, so as to make the retreat of the person engaged more safe. The proportion of props recovered increases with the quantity set up.

With regard to the connection of accidents with the degree of supposed safety of the roofs, it may be remarked that comparatively few accidents happen to persons working where there are very bad roofs. In such cases, as a rule, greater care is taken by the miners, and the officials invariably see that the security of the roof is more systematically performed. Where the roof is of a medium nature as regards its liability to fall, accidents are more frequent In these instances, it is more common to leave the matter in the hands of the miners and the subordinate officers to act as they deem necessary from time to time, than to organize a

system of securing the roof to be carried out in all cases. Miners cannot always detect when their places are not so safe as at ordinary times. They perhaps act precisely in the same manner as they have done hundreds of times before, under apparently similar circumstances, until the advice of others is little regarded, and then an accident occurs. When the roof is considered safe it is looked upon by many miners as quite unnecessary to set up props when asked to do so, yet many lives have been lost by falls of roof in places which, before the accident, have appeared to practised eyes quite safe. In short, a collier relies on his opinion instead of insuring against the possibility of his judgment being at fault.

The conclusions which the writer has drawn from a consideration of this subject are (1), that where props or other supports are set up only when considered necessary, even by experienced persons, accidents are of frequent occurrence, the results showing that the means of detecting danger from falls are not sufficiently certain to be relied upon; and (2), that in order to reduce the number as far as possible, it is desirable to consider the practicability of supporting the roof and sides on a definite system, irrespective of appearances of safety, the props and other supports being placed at specified distances apart, and *as soon as possible after the roof and sides are exposed.* These props or other supports for the roof need only remain so long as required for the protection of the persons employed.

Athough advisable for securing uniformity, it would not be practicable to apply a hard and fast rule, and make all miners alike as regards the distance apart which props might be placed. The precise manner in which the system should be carried out seems to require that the special features of each mine be carefully studied, together with all available information regarding the practices in similar instances, and the results which have followed therefrom.

The PRESIDENT—It is proposed to open the discussion of this paper to-night, as we have some time. I will be glad to hear any remarks. As Mr Robson says, a paper of this kind needs no apology. Without giving any opinion now upon it, one remark strikes me: It very rarely indeed happens that a man is injured

in the act of endeavouring to get away from a piece of coal which he was trying to bring down, or while he is trying to bring down a stone from the roof. Most accidents happen when they are not expected, when people are not guarding against the dangers. It is frequently said at the enquiries which follow on these accidents, that "We told the man this was wrong;" "The fireman says, 'I told him to place so and so'; and the man said when he got his hutch filled he would put up a prop;'" but in nearly all cases it is the "unexpected that happens." In my last year's report, we took the trouble to note the number of days men were idle from accidents. Some men were idle sixty days with a broken leg, and still off, and some a hundred, and still off, when the census was taken. Now, there is no doubt whatever that falls can be better guarded against than they are. Could there be anything more clear than this, when men are so seldom injured in getting away from the material they are trying to bring down? Accidents may happen after a shot has been fired, and the man goes in below his holing without sprags, and the coal comes away, but that can scarcely be called an accident,—he has done the thing himself. In the same way, we cannot call it an inevitable accident if a man relies on his own judgment in the matter of supporting the roof. Circumstances may alter unknown to him, as Mr Robson has put it, and the roof comes down unexpectedly, because he did not prepare for it. You cannot call that an accident which could not have been guarded against. I shall be very glad to hear the gentlemen present here to-night, and those who will read the paper, express themselves very freely upon it. I daresay all of you in my district know where I think props should be. Whether they are to be set up by the colliers or men for the purpose, the work should be done on some principle to be laid down by some one in authority which would secure uniformity, and after all I suspect you must not depend upon the judgment and skill of any man for the detecting whether the roof will be bad, but make your arrangements on the supposition that it is always bad. I would like to see a good deal of criticism on Mr Robson's paper which he has taken a good deal of pains to prepare for us.

Mr AUSTINE—Really I did not intend to make any remarks to-

night, but since you have asked me I will make a remark or two. I think it is an astounding statement the President has made,—and there cannot be a doubt about the truth of it,—viz., that accidents from falls of the roof generally occur for want of due precaution before the accident happens. I think, speaking to you gentlemen who have charge of pits, it is imperative for you all to impress upon the men who look after the proper treeing of the places, not simply to say to the collier, so long as the collier is expected to put up the trees, a tree should be put up here, but he should never leave the place till it is done; and I am fully impressed, from what the President has said, if you all could do that, and try and teach the men under your charge to see their work properly done, great good would follow. It is a serious matter, recollect; and in addition to the necessity for taking care, already on young shoulders, after the New Year, there will be a great deal more. I would make it imperative for every man who has the slightest charge, so long as it is the colliers' duty to do it, to see the work as I have described done before leaving. Almost universally, these accidents take place from want of precaution. A case came under my notice this very day, not of an accident of that kind, but of a man appointed to do a certain thing and not doing it—not taking the slightest precaution, and yet he is paid for the purpose. Undoubtedly it is the duty of managers of collieries, when they see a case of that kind, to put their foot on it. I would have no mercy. Recollect the law will have no mercy on you. The law has no mercy on the proprietor of a colliery, and by and by it will be worse. One cannot be too guarded, in the prevention of accidents, to see that every small precaution is taken.

The PRESIDENT asked Mr Robson if he had anything to add?

Mr ROBSON—Nothing at all.

Mr MACCREATH—It is a great privilege to listen to such a paper, and to get the benefit of Mr Robson's experience and also the President's, but I daresay the different members would like some time to consider it.

Mr BEGG—I would like to take up one point on which Mr Robson pretty freely expresses his opinion, and on which I cannot quite agree with him. Mr Robson seems generally to say

that in propping a rule ought to be followed and strictly adhered to,—that is to say, the trees are to be set at a distance from one another, and I take it that that rule is to be followed throughout the whole mine without attending to the necessities of the roof or any special matter that may take place in any particular district. Is that what you mean by the rule you propose?

Mr ROBSON—You will find that I do not propose any rule which would make it unnecessary to use special precautions where special danger is seen—I mean that there would be a minimum quantity of propping in every case below which nobody would dare to go.

Mr BEGG—If you, then, alter your rules to suit your circumstances, where is your rule to apply? What rule do you wish made for the setting up of trees? Is it not after all, "Leave it to the skill of a person set to watch," or as in the present circumstances—or, I should say generally in the present circumstances, —"Leave it to the skill of the miner himself." He judges where a tree is necessary and puts it up.

Mr ROBSON—Sometimes he fails.

Mr BEGG—It is intended he should do it. If you adopt a rule for the setting up of trees, the collier will depend entirely on it, and the tree may be set up within an inch or two of where it is required for protection and yet leave exposed a bad roof break. What I feel is that a rule of that kind could not be adopted without overriding the skill and judgment of the men, and I therefore think to adopt any rule of the kind would do a great deal of harm. It would make a man adhere to the rule rather than exercise his skill. The one is much easier done than the other.

Mr ROBSON—I can only say that Mr Begg's views are diametrically opposed to mine.

Mr AUSTINE—I will just add, failing the experience of the miner, the roadsman or fireman that goes from place to place to see that the roof is properly treed has the power to see it done, or do it himself. Just as I said a little ago, never leave a place till it is properly treed.

Mr HASTIE—Does Mr Robson suggest that wherever coal is being taken out trees should be put up no matter what the nature of the roof is? The way I want to bring up that is, I

remember one day the President and I were going through the pit at Greenfield, and he found fault with some of the workings, because there were no props. I just asked the question, who was to be the judge? I said I could take out the coal without props with perfect safety, for there were 12 to 15 feet of rock overhead. He considered it dangerous. I said I was to be the judge for the Company if I could take the coal out with safety in any section, and I think I was quite justified in doing it. As a proof it can be taken out without props, the roof of places where the coal was wrought out fifteen years ago is standing to this day. I therefore, do not see the necessity of propping these places at all.

The PRESIDENT—That is a proof my judgment was wrong.

Mr HASTIE—Yes; at that particular point. (Laughter.)

The PRESIDENT—I think what Mr Robson says is this: there will always be accidents from falls of roof. Many occur where least expected, and many would be saved if a regular system of propping were to obtain, without depending always on the skill of the men. With regard to Mr Hastie's remarks, suppose he had been wrong with this fine roof, I would have been right—(laughter)—and it is just as likely he is not always right as that I am not always wrong.

Mr HASTIE—Certainly, but in certain cases we must be the judge how many trees are to be put up.

The PRESIDENT—Mr Robson's paper says, "Be the judge as much as you like, as far as you can, but, inasmuch as the best are deceived, this would be the means of decreasing the number of accidents." I think that is the length Mr Robson goes?

Mr ROBSON—Precisely.

The PRESIDENT—But there may be other means, and we would be glad to hear if there are other means. The chief point is the great number of accidents, and every one of us feels after an accident has happened, "Surely a thing of that kind—at least in nine cases out of ten—could be provided against." Mr Robson's system would catch some of these if props were put 2 or 3 feet apart, or some other distance. In Blantyre, for instance, the special rules require a sprag every six feet, and there has only been one accident from a fall of coal there since that system was adopted, and there used to be many. Now, if there

were a prop every three, four, or five feet, it might do good. The question of expense never enters into your mind. It is the usefulness of it, and if it would only save one life or one accident out of ten what a benefit it would be. That is the reason why Mr Robson says systematic propping would tend to safety. It would not prevent all accidents, because no one thinks that absolute safety can be reached, and, until this paper is contradicted, we, so to speak, stand committed to the opinions expressed in it.

Mr M'CREATH—At Blantyre, are the sprags put in before the miner holes.

The PRESIDENT—Wherever he can get a sprag in he puts it in.

Mr AUSTINE—Are they long-wall workings?

The PRESIDENT—Yes, and I believe it gives them rounder coal.

Mr AUSTINE—It has been practised now for thirty years at Ridding. The sprags are knocked out after the day's work is done, and when they come back, there is forty yards down in a lump, which it will take them two or three days to break up.

The PRESIDENT—Now Mr Hastie, give us some remedy.

Mr HASTIE—Oh, there will nothing beat the remedy of putting up plenty of wood.

The PRESIDENT—We are all at one.

Mr FAULDS—I quite agree with Mr Robson in a good number of his ideas. I have no doubt that a number of the members here have splint coal workings under their management with a bad roof, and in our colliery we make the men—in fact, compel them to put up larch straps two and three feet apart. We even put up lids, some of them three feet long, on the top of the trees, and secure the roof close to the coal face before the coal is taken down, and we have very seldom falls from the roof. I think it is quite necessary to stipulate a certain distance for propping when the nature of the roof is soft as in splint coal.

Mr AUSTINE—Stipulating a proper distance does not prevent the miner, if he thinks proper, putting them thicker.

Mr FAULDS—Stipulate a certain distance and see that the sub-officials carry it out. Of course it is the managers' fault if such instructions are not executed.

Mr WADDELL—As I may not have the benefit of next night's discussion, I would like to say a word. Mr Robson in his paper

suggests that if sufficient precautions are taken accidents from falls would not take place. My chief difficulty is how to guard against the "unexpected." After an accident has happened, and we have seen the fall, we are pretty often able to say "Well, had we known this, we would have prevented it." My difficulty, as I have said, is how to guard against the "unexpected." Of course where carelessness comes in, it is quite a different matter.

The PRESIDENT—What Mr Robson appears to lay down is this: we never will prevent all accidents. It is evident that depending upon the skill and judgment of the parties themselves does not prevent accidents even supposing that each man does his duty, and in order to save some of these accidents from the "unexpected," if we could put up props, some of them would hit the place, would be useful and so would diminish the number of accidents. In short, not to rely entirely upon our own judgment, but to put up these props so that on some occasions—not on all—they may prevent accidents, and after you have done that to trust to your own judgment in addition.

The President then announced the adjournment till next night of the discussion, and in doing so he expressed the hope that the paper might be fully criticised, and stated that before then he would manage to get Mr Robson to look up a few statistics which might show them what was done in other places, if these would be of any use to them, although they had plenty of information within themselves to deal with the subject. All that they wanted was to advance a little and to ventilate their opinions freely, and he had no doubt much good would be done.

PLATE VIII.
M.I.S.

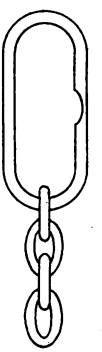
r on a

N INCLINES.

Hook.

Link.

Fig. 3



Sideview of Link.

Fig. 4

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING, 11th NOV., 1880,

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON.

RALPH MOORE, Esq., President, in the Chair.

THE Secretary read the minutes of the last General meeting and Council meetings, which were approved of.

The following gentlemen were then balloted for, and admitted as Ordinary Members :—

THOMAS JOHNSTONE, Agent, Bothwell Collieries, Bothwell.
JAMES ADAMS, Firebrick Manufacturer, Hill of Beath, Fife.
WILLIAM CHAMBERS, Wood Merchant, Motherwell.
ALEXANDER CUNNINGHAM, Civil and Mining Engineer, Gavin Bank Hamilton.
ROBERT MUIR, Coalmaster, Stonelaw Colliery, Rutherglen.
KENNETH M'KENZIE, Coalmaster, New Bank Colliery, New Cumnock.
JOHN DOCHERTY, Colliery Manager, Elgin Colliery, Dunfermline.
ALEXANDER NASMYTH, Colliery Manager, Donibristle Colliery, Fife.
DAVID SEGGIE, Colliery Manager, Merryton Colliery, Hamilton.
JAMES KNOX, Collery Manager, Allanton Colliery, Newmains.
JOHN THOMSON, Colliery Manager, Stevenston Colliery, Holytown,
ALEXANDER SHARP, Colliery Manager, East Law Colliery, Carluke.
ROBERT BAXTER, Colliery Manager, Benhar Colliery, Whitburn.
ROBERT CHRISTISON, Colliery Manager, Trees Colliery, Bathgate.
DAVID CRANSTON, Colliery Manager, Muldron Colliery, Fauldhouse.
ROBERT CARMICHAEL, Oversman, Earnock Colliery, Hamilton.
WILLIAM M'FEDDRIS, Oversman, Cadzow Colliery, Hamilton.

Other nine gentlemen were then nominated as Ordinary Members, and will be balloted for at the first meeting.

BERNHEIM'S PORTABLE FIRE ANNIHILATOR.

The PRESIDENT—Mr Tennant of Glasgow is present, I understand, to explain Bernheim's Portable Fire Annihilator. I propose that we hear him prior to proceeding with our regular discussions.

Mr TENNANT—I was indebted to Mr Hastie of Greenfield Colliery for, in the first place, drawing my attention to our Fire Annihilator as an apparatus especially suitable for coal-pits. We had a testimonial of its particular efficacy from him, which I published in the shape of a leaflet, and had it sent pretty extensively abroad over the neighbouring colliery district, and the result has been that the Annihilator has been accepted almost universally among the principal coalmasters of the country. That has actuated me with the wish to have it universally adopted in every colliery. Wherever the apparatus has been tried experimentally, they have invariably reported to me that it has been thoroughly effectual in extinguishing the fire within two or three minutes. The managers of Bothwell Collieries had a practical opportunity of testing the Annihilator at an underground fire a few weeks ago. They have a very abundant supply of water at the pit, but it was quite inadequate to put out the fire; they sent for the Annihilator, and in three or four minutes after it was applied, the fire was completely extinguished. Well, that is accomplished by the liquid which is put in here (showing) in the proportion of one part, or two parts of liquid to eight or nine parts of water. In the case of need, by increasing the quantity of liquid, the more active is the extinction of the fire. As far as the machine itself goes, there is very little explanation required. This (shewing) is simply a double force pump, pumping exactly the same as the engines of fire brigades all over the country. It is, in every respect, as efficacious as the fire-pump of Mr Bryson, and while with their hand-pump, which requires three men, they throw 42 to 43 feet, with this machine, used by one man, we throw as far. Unlike Dick's Extincteur, which

exhausts itself, and thus diminishes the supply, if the fire necessitates it, you simply keep pouring in a little more liquid and water. The great secret is in the liquid, which is, I believe, the most extinguishing liquid that has ever been known.

Mr SMART—Is the liquid composed of carbonic acid gas?

Mr TENNANT—No; it is pure and simple liquid. Carbonic acid gas is generated only when it comes in contact with fire. It is only when contact takes place that the fire gets the benefit of the liquid. In regard to Dick's machine, the gas is generated in the machine, and as it escapes it loses its effects. In our case, the fire gets the full benefit, and the result is immediate extinction. Fire cannot live beside this liquid, and perhaps its greatest beauty is, that it is not only fire extinguishing, but fire proof, so that whenever this liquid touches a substance it is fire proof. If you have coal taking fire, you can make a wall of division by putting a jet of this liquid over it, so that fire cannot pass over it, and it will not re-ignite.

Mr SMART—The only fear I had was that it might generate a fatal gas.

Mr TENNANT—That gas escapes instantly; it is never seen.

Mr SMART—It might have some effect on animal life?

Mr TENNANT—We are quite prepared to prove that the thing is dissipated instantly. It has no possible effect on animal life, none whatever.

Mr RONALDSON—If carbonic gas is generated, that gas is mixed with the air of the pit. It cannot die instantly?

Mr TENNANT—We are told so.

Mr RONALDSON—It must have something to destroy it if generated.

Mr TENNANT—It is of so small amount that it cannot possibly injure any one.

The PRESIDENT—Whatever destroys fire destroys life.

Mr TENNANT read from a report by the Manchester Public Analyst that the liquid was completely innocuous.

Mr SMART—One reason I had for asking was, we had a fire at Ferniegair and we got an Extincteur. I cannot say what the composition of the stuff ejected from it was, but it travelled 200 or 300 fathoms and reached the stables, and I blamed it for killing

a number of horses. That was the reason why I wished Mr Tennant to explain if the liquid was dangerous to animal life.

Mr TENNANT quoted in extenso the public analyst's report.

The PRESIDENT—Mr Grant, I think you had one of these at an underground fire you had lately?

Mr GRANT—I tried it, but it did very little good. Perhaps the fire was too strong for it.

Mr TENNANT—Where was it?

Mr GRANT—At Craighead.

Mr TENNANT—Mr Johnstone told me of that. They had only one machine and two or three gallons of liquid. If he had told me, I should have given him 50 gallons of liquid as an advertisement for the purpose of proving that it should have gone out in so many hours instead of days.

Mr GRANT—I believe we would have been glad to see it.

The PRESIDENT—I saw that fire. It burned from Monday till Sunday, and was of this nature: a blower of gas had got kindled by some means, and not only the blower itself, but for a distance of 10 yards the feeders were burning, and about 8000 feet of air was going through it. The question running through my mind was, what would have been the use of your engine there with such a quantity of air going alongside of it? I would scarcely be inclined to say the machine was useful where there were a great number of blowers of gas coming out unless the liquid was applied in very large quantity, but I by no means say that in many cases it would not be useful. The tendency of inventors is to make it appear that these machines can do what they are incapable of doing, and so disappoint people who use them. I do not think the liquid could have extinguished the Craighead fire. It was simply put out by the burning materials being cut away by hard work. There can be no doubt that the objection which Mr Smart made would apply to some greater or less extent, how much I do not know. We know that these machines are useful in destroying fire because they contain something which will not support combustion. In cases of fire in wood work,—and we have far too much wood about our pits,—and in many other instances where it is taken at once, the instrument might be very useful.

Mr TENNANT—That is really the way with all extincteur operations.

The PRESIDENT—With regard to gas, I do not think it is of very much use. While on my feet, I will read a very good letter I received the other day; it is worth reading as showing the attention people have been giving to devise some means of making carbonic acid gas on the spot to destroy underground fire :—

17 UNION STREET,
HAMILTON, *Nov.* 8, 1850.

DEAR SIR,—Pardon me for taking the liberty of writing to you; but, knowing that you are the President of the Mining Institute of Scotland, I beg leave to state a few practical facts that came under my own observation, which may prove beneficial where the feeder of gas takes fire in coal mines, viz.—the passing of atmospheric air over burning wood makes carbonic acid gas, and how I found it very useful afterwards in practice. In 1865, I had the looking after of the fire-damp in a stone mine at Ferniegare Colliery, under Mr Dunn. The mine was about 40 yards in length, and 8 feet in breadth; we had got fully half of the coal, the feeders along the side and pavement were many and very strong; they extended for nearly 10 or 12 yards along the floor of the mine. When preparing a shot some of the feeders caught fire, either from the match or the straw, in a few seconds the whole of 12 yards was in flame, from about a hundred feeders of gas. The first duty was to try and get them extinguished; we went with our coats and worked hard for nearly an hour, all to no purpose: for, as soon as we got one half put out, the gas from the feeders that were out gathered in volume and re-ignited at those we were trying to get out. By this time the mine became very hot, the only thing we could do under the conditions was to wall it up with brattice, but before doing so I had to go to the pit-head, for there was none at hand suitable; by the time I got back, the wood brattice and gear legs in the mine had caught fire. I will assure you that the tunnel-head of a blast furnace was nothing to the flames that were proceeding from the mine; indeed, it was impossible to face the return air-course of the mine. Our only hope was the nailing up of the intake; this was soon done, and then we could face the return which we proceeded to battrice up, but before we had got two-thirds done all our lights were put out from what I thought at the time to be smoke, but since have proved to be carbonic acid gas. We went to the pit-head and remained there for about five hours, after that time I went to see what state it was in; the return was quite cold and giving out pure gas. I took this as being very hopeful that there was no flame inside of the mine, so I proceeded as cautiously as possible to see if anything was burning. There was none, all was as cold as if flame had not been there, and, strange to say, all within about six hours from the time that it was burning as a most powerful furnace. The coal had been

on fire in many places—the quantity of wood burnt was two lengths of brattice, six lengths of gearing, with another length of brattice, and a set of gearing charred. After I went to Greenfield Colliery, I proved that the theory and practice of passing atmospheric air over burning wood held good, and I used to keep a length of old brattice for the purpose, as there was scarcely a week without the east level taking fire. In every case where I used to burn a length of wood brattice it was always ready for working in an hour or so. There are many workmen in and about Hamilton who can vouchsafe for the truth of what I say; yet, I am of opinion, that one length would not have done in the case of Ferniegare mine, it would have required more. The oversman and the fireman, seeing me so successful, thought that they would try their hand, but with very different results; although, I must say, that I never told them about using the wood. When the level took fire they just walled it up with brattice, without allowing any to be burned; when walled, some of the feeders went out but still made gas and gathered in volume till they caught fire at those that were still burning. It blew up and burned them very severely, and wrecked one side of the pit.—Your obedt. Servt., J. B. GALLOCHER.

That is just an extincteur. I daresay it may be the experience of many of you that such a thing has done some good. That is just after all what led Stevenson to the Stevenson Safety Lamp. There was a big blower at the bottom of the pit, and he found that by putting a light on the windward side it spoilt the flame of the blower a little, and by putting more lights he put out the gas altogether. Hence, he said, "If I make a lamp with a glass cylinder and small holes in the bottom only sufficient to supply air to the light, whenever it goes into gas it will go out, because sufficient air to supply the combustion of the gas cannot get through the holes." That is just the principle that Mr Gallocher states here.

Mr HASTIE—I am of the same opinion—viz., that this machine would be of little use at a fire of this kind. I tried it on the surface, and it was with reference to that I gave the certificate published in the leaflet. My opinion was that, below ground, it would be useful only in a close place—that is, a place say 20 yards forward and no air; but for such a fire as at Craighead, it would be of no use. It would be useful, as I have said, in a close place, because it would throw up the liquid 40 feet, and even using it with water, and not with liquid, it is a useful machine in such a place.

Mr TENNANT—I shall only ask the favour that if any man is anxious to make the experiment, he will be kind enough to let me know, and I will supply him with the liquid.

The PRESIDENT—You have heard Mr Tennant's explanation, and I suppose we are all willing to give him a vote of thanks for his trouble in coming here and explaining his machine.

DISCUSSION ON MR STRAIN'S PAPER.

The PRESIDENT—We will now pass on to Mr Hugh Strain's Paper upon "Reid's Safety Cage and Detaching Hook." It is a safety cage and detaching hook. The two are inseparable. You must use them both, as I understand?

Mr STRAIN—It is a safety cage. For instance, if the rope were to break, it would act without the hook.

The PRESIDENT—The detaching hook would not work unless you had the safety cage. It would not be efficacious?

Mr STRAIN—No.

Mr BARROWMAN—Although the accidents from over-winding and from breakage of ropes are few in number as compared with other mining accidents, I think any appliance by which life may be saved merits consideration, and I think we should look at this apparatus with some interest. He is a local person who is introducing it. I think we should countenance local attempts. (Hear, hear.) It seems to me that this cage, taking the two parts of it—the hook and the safety cage—has the most of the merits which are to be found in these apparatus and the fewest defects. The great merit of this apparatus is its simplicity and the absence of springs. We all know that through the action of water on springs they cease to work properly, and the awkward thing is just when wanted to act they are out of order in many cases. I would point out what seems to me to be one defect in it, viz., that the claws that grip the slide, grip it only on the front. Now, it is plain that unless the slide is perfectly rigid, the claws will not act instantaneously or satisfactorily. It seems to me that with a slight alteration of

the mechanism of the thing, the claws might act at both sides of the slide instead of on the front of it and secure a better grip. I am of opinion that this apparatus does not meet the difficulty which arises when a rope breaks between the engine and the pulleys. In looking up the "Transactions of the North of England Institute," in connection with a committee appointed by that Institute some years ago, it is noticeable that those reports given in which, stated that the rope broke between the engine and the pulleys, also brought out that the safety apparatus did not act; and it seems to me that this apparatus does not quite clear our minds of that difficulty. I am afraid that if there is any interruption of the fall of the rope the safety appliance will not act so quickly as to stop the cage in the shaft.

Mr FAULDS—I was not present when Mr Strain's paper was read and last discussed. About the bottom of page 118, he says, "It is necessary that the slides be strong and well supported by buntons," &c. Would the tear and wear of the slides, although supported as he says, not be considerable at top and bottom of shaft caused by the working of the claws of the jaws or prongs (F) at these points. Perhaps this tear and wear could be avoided by substituting iron for wood at these points. On referring to the drawing, you will observe that the tails of the levers *(h, h)* are exposed. Are they not liable to be disengaged from the link *(g)* of low chain (D) by coal or other materials falling upon them in the shaft? How is the pin *(e)* connected to the low link *(d)* for working the jaws or prongs (F)? I presume the claws at end of jaws or prongs (F) act at all times of detachment, and that the effectiveness of their acting is caused by their constantly working while resting the cage at top and bottom of shaft.

Mr STRAIN—I think the gentleman who spoke first is quite right as regards the grips. Since the paper was printed, it was suggested to Mr Reid to grip the sides of the guides instead of the face, and I had a letter from him saying he had made up his mind to try and do so. It will secure, in the event of the slides not being well secured by buntons, the proper action of the apparatus, which might not otherwise take place.

The PRESIDENT—This safety cage and detaching hook may be considered separately. The safety cage is a very old thing. I do

not at this present moment recollect whether it was not invented by the late Mr George Simpson, C.E., or by the late Mr Lumsden, mineral manager of Dundyvan Iron Works, but certainly I have seen it 30 years ago, and I have seen it also in some foreign publications. The objection to the catches on the side was at that time very strong. White & Grant's cage, which worked with eccentrics gripping the guides, was about 30 years ago very much adopted, and also their detaching link, which was very simple. I do not know if our "Transactions" contain any record of it, but it was a very pretty thing and worked very well, but like all those things the novelty wore off, and I do not know if any of them are in use, except those at Govan Colliery. I rather think that in the case of a rope breaking while the cage is descending, or the rope breaking behind the pulley, that it would not grip—in fact, we have very good instances that it would not grip. So that, as regards the safety cages, this cage is neither more nor less than the old cage with all its defects and any benefits it may have. In regard to the detaching hook, well it is one of many, and I do not think it is very much better or worse than other safety hooks. I never could make up my mind that any of them were good. What safe guards have you now against over-winding? You have three. You have the link motion, which is a very perfect over-winding protective; you have the brake; and you have the throttle valve. All these three are meant to stop the cage at the proper place, and what the promoters of safety hooks say is—here is another arrangement which, these failing, will prevent over-winding. Now, what occurs to me is, let us perfect what we have got. Let us have a better brake if it is not sufficient; let us have a better throttle valve if that is not sufficient; let us have a better link motion if that is not sufficient. With these we can make the engine creep or make it run at miles an hour. When men are ascending on the cage, the engineman should drive the engine so slowly that he can stop at any point. There is no excuse for overwinding with men, unless some part of the machinery fail, or something happens to the engineman. We have, therefore, to decide between this and the chance of failure of the hook when required to act; and, in my opinion, there is much less chance of the

former failing than the latter. With regard to overwinding when the engine is drawing coals, I do not think that we are entitled to risk the failure of this hook, when men are riding, in order that property may be saved. We are obliged to Mr Strain for bringing it forward. We should encourage local talent, and this is just as good as anything I have seen.

DISCUSSION ON MR ANDREW'S PAPER.

The PRESIDENT—The next paper for discussion is that of Mr Andrew on "Cut Chains. Have you anything, Mr Andrew, to explain further than what is in the paper?

Mr ANDREW—No, I have nothing else to say than what is in the paper.

Mr DRINNAN—I am scarcely prepared to say anything, but was hoping that I might elicit something from the discussion with regard to the working of this haulage system. I cannot say I fully apprehend the way of working. I have only had time to look at the paper for a few minutes.

The PRESIDENT—The object is pretty well explained in the paper itself. It is, that by means of one incline you draw coals from five or six different levels.

Mr DRINNAN—There is just one other difficulty I have. I understand it is a double line of rails up the whole length of the incline, and the empty hutches will be going up on a different line of rails from the full ones?

The PRESIDENT—Yes! The benefit, of course, is that the drawing roads are all level. Then by and by they get so long that one hutch will not take away the weight of the chain, and they make a separate incline.

Mr DRINNAN—Would it not be possible to make an incline work a greater length by putting on two tubs?

Mr ANDREW—When the gradient is so steep it is not easy to

flatten it out at the benches as you would require to do before you would have accommodation for turning off two tubs from each, but that can easily be done at the top. It is possible to brush a piece out at the top of the brae to raise the incline higher than the head of the incline, but it is not practicable in the centre of the brae, because if you flatten out the place for one hutch, only short rails are adopted, whereas for a pair of hutches, you would require long rails, very heavy and not easily handled. A four feet length rail is sufficient for one hutch benches, but seven or eight feet would be short enough for a pair of hutches. The rails, too, would be bent and, unless malleable, would get broken, and would not be manageable for boys.

Mr ANDERSON—If the cut chains are in between the rails when a race is coming down, are they not liable to get entangled?

Mr ANDREW—We do not find any great difficulty on that account.

Mr RONALDSON—Do the drawers themselves work all this traffic; or is there a person to superintend?

Mr ANDREW—The drawers do it themselves.

Mr RONALDSON—Suppose you are taking a full hutch from D (see Plate No. 8), who attaches all the cut chains between W and E?

Mr ANDREW—The cut chains are always put in by the drawer after he has run his tubs.

Mr RONALDSON—Suppose you are taking a full hutch from T, is it possible to get across from T to the opposite side across the chain, or must it be that the end of the chain at B is up at T?

Mr ANDREW—Oh, no! it is quite easy getting across; you just hang up the chain. Sometimes they run the hutch across the chain. It is found to be no obstacle, but I dare say the tear and wear would be considerable. There is an arrangement in the shape of hooks for holding the chain up, and the hutch passes beneath it.

The PRESIDENT—What is the steepest gradient you work these on?

Mr ANDREW—One in $3\frac{1}{2}$. We have wrought them one in 3, but the empty hutch is apt to be tipped over. However, there is what is called a "bridal" for resting the coupling, and the main chain passes through; at one in 4 the tipping over of the empty hutch never happens with the use of the "bridal."

The PRESIDENT—Do you find in point of expense one in 3 as cheap as one in 4?

Mr ANDREW—It is as easily wrought with the exception of the tipping of the empties. At one in 6 the speed requires to be helped, whereas at one in 3 the motive power is greater for the same length of incline.

The PRESIDENT—Can you draw coals as cheaply at one in 10?

Mr ANDREW—More cheaply at one in 10 or 12 than one in 4.

Mr SMART—You are not drawing with these cut chains at one in 10?

Mr ANDREW—No, one in 6 is our flattest gradient on which we have "cuts."

Mr SMART—When you say you draw them cheaper, it is in consequence of having a self-acting incline?

Mr ANDREW—The "cut chain" inclines are only, I suppose, for that purpose,—to meet the requirements of a steep seam?

Mr CLARK—Mr Drinnan asks if is practical to work with two tubs. At Arniston, they had them all with two tubs, and the two worked as cheaply. The gradients were one in 3 and some steeper; the rails that cross the branches were in nine feet lengths.

Mr DRINNAN—I am surprised to hear Mr Andrew say it does not work at one in 3 satisfactorily. I have one nearly one in one, and it is rare indeed that we have such an accident as a hutch tipped up. If the road is in good order it never happens. It is always when something has gone wrong with the road.

Mr RONALDSON—One objection to this system that I see is its limited application. It can only be applied for a length of say 70 yards. Now, referring to this sketch here, there being a distance of several yards from S to W, from the head of the one incline to the foot of the other, that necessitates extra labour. The system we saw at Niddrie of working with a cuddie and a boggie, seemed to be able to work over a much greater length, there being one incline instead of two.

Mr FAULDS—In Mr Andrew's paper, he says, about top of page 122:—It is only when the inclination is about from 1 to 3 to 1 to 6 that "cut chain inclines" can be wrought advantageously; and on page 123 he again says—it is necessary that 2 or 4 runs should

be made from each branch at a time, as if only 1 or 3 are made the cuts cannot be put together to allow the next branch to run at N unless the "cut" be put across to the other side of the incline to be connected. By this system one tub is run from each branch and two from top of incline. These inclines are made every 60 yards, so that between every two of them the tubs are drawn on the level. Is this not a slow method of haulage, and would slope inclines or roads, running six tubs at a time, not be speedier and, consequently, command a larger output. This system of haulage might be advantageously adopted for working the area only between the slope roads and direct to the rise of the levels.

Mr CLARK—It is quite customary instead of having the two so separated to have them near the plates, and just take them off the one chain and put them on to the other.

The PRESIDENT—It is a very useful device, very well worth taking into consideration and trying where it is suitable. It is very remarkable in Fife that you see no "snibbles." The men draw on level roads, and inclines are used where they can be adopted, and that is something. It may be that in flat workings, such as we have hereabouts, "cut chains" could not be adopted, but still in many cases I think something might be taken from them; and you will all agree that Mr Andrew has done us a good turn in bringing this paper before us, and give a cordial vote of thanks for it. (Applause.)

DISCUSSION ON MR ROBSON'S PAPER ON "FALLS OF ROOFS AND SIDES."

The PRESIDENT—The next business is the discussion on "Falls of Roofs and Sides." I will be glad to hear the remarks of any gentleman on the subject. It has been before you for the last month, and you have had time to think over it. It may be useful to begin the discussion by reading to you a letter from Mr Forgie, who is unable to attend the meeting.

Mr FORGIE—Being unable to be present at your meeting I send the following few remarks in the hope that they will be read by the Secretary. I have read over Mr Robson's paper with much pleasure, and consider some of the suggestions made therein most valuable and worthy of the serious consideration of the members of a Mining Institute. Accidents from falls of roof and sides have formed a very considerable part in the inspector's yearly catalogue of mining disasters, and any means that can be used to reduce their number must be commendable. Of course, what may be required in one colliery may and certainly is not required in another; but there are exceptional cases again where far more than the average precautions are required. The matter of propping systematically does not receive the attention due to it from colliery officials. There is practically no colliery that does not require a certain amount of propping, however small, and the only question that lies with the officials is—What is the least amount of propping that can be done to ensure the comparative safety of the workmen? Where this has been arrived at, in no case let it be less, and where circumstances appear to require more, let it be done immediately. A systematic arrangement in both long-wall and stoop-and-room of stipulating the setting up of props at certain distances from one another would certainly prevent a large number of the accidents which now occur, through the misjudgment of the officials and miners in thinking places secure because of the good appearance of roofs, and no proprietor could reasonably object to such being done, when increased safety to life and prevention of accidents would accrue therefrom. I may give my slight experience of a systematic arrangement of propping, and there may be one present at your meeting who may be able to corroborate and say a little more about it. At a colliery near Hamilton the rule was made of setting up props at certain distances, independent of all circumstances which might suggest themselves to the minds of the officials that so many were not required. The distances were never increased, although the miners or officials were never prevented, but, on the contrary, encouraged to put a larger number of props if they thought necessary. The result was, that not a single accident occurred as long as my experience lasted, through

falls of roof; not but that they might have happened, but the fact speaks a little in favour of systematic propping. There is no mistaking the fact that the greater the number of props that are put up the greater the number taken out in good condition, and the greater the safety to the workmen, within certain bounds of reasonable economical working. Mr Robson advocates another advisable point, and that is, that when any official in going his rounds sees that a prop is required, or that the systematic arrangement is being neglected, he ought not to leave that place till he enforces the rule, and see the place made thoroughly secure. This would in a great measure make the miners more attentive and active in carrying out the work without *putting off*, as all miners are decidedly inclined to be careless, even in matters concerning their own safety.

Mr BARROWMAN would ask, as it has an intimate bearing on this question—How is it that, as a rule, firemen, roadsmen, and surveyors are not hurt by falls? I suppose it is because there is more caution exercised by these individuals. This suggests another question. What is the educational status of the large majority of those who are injured by falls? I do not mean simply the knowledge of the three R's, but the knowledge of mining generally. Is it not a fact that the miners as a class, especially in these days, are woefully ignorant, and that there is no standard of ability with regard to them? Is it not the case also that miners are foolhardy in proportion to their ignorance? With reference to the preventing of falls of roofs and sides, my opinion is that we ought to perfect the appliances we have. The chief appliance is the miner. He is the one most intimately connected with this matter. We cannot, however, wait till education works wonders upon the future generation, and gives us men in all grades of society who will act consistently, intelligently, and well in their various spheres of duty. We have just to work with the means at our command. Meantime men are being killed, and we must use the means we have to protect them—even from themselves. It would be interesting to know if the accidents by falls from roofs and sides are more numerous per ton raised now than they were years ago. The Chairman in his remarks last evening says, the "question of expense never enters into your mind." I rather

think I could answer for nine-tenths that the question does enter into our minds—in fact, it just becomes a question of expense. However, I think it is for the Institute to point out to coalmasters a direction in which this recommendation of Mr Robson's can be acted upon without entailing very much additional expense. It seems to me, more particularly with roofs in stoop-and-room working, that this might be done. A great deal more prop wood might be put up than is at present the case in this district, with a view to the stoop coal being taken out within a shorter period. It seems to me if coalmasters were to put in more, it would be in their own interest to take out the coal before that wood decayed. In this way the wood would be useful in the first propping and also in the stooping. Probably, also, the coal would be stooped in smaller sections than is now customary, and be thus saved from deterioration by being exposed to the air.

The PRESIDENT—I wish to say in passing, that statistics tell us there are fewer accidents from falls of roofs than there were 30 years ago per ton raised. I think education, taken in the abstract sense, is very useful, and nobody would say in these days that, because he is educated, he is a worse man. But I daresay every one of you would as soon go into a dangerous place with a fireman as with me, or any one like me. There is not much mystery in the detection of gas. A firesman becomes very active in detecting gas, and is as good as any person, however well educated. Mr Drinnan, you have been in some English mines.

Mr DRINNAN—The seam worked where I was is called the Yorkshire and Derbyshire "Top hard," and the system in use there will be known to most here, I daresay, as the "long-wall" system, differing from the Scotch system only in the length of their banks or places—60 yard banks they are called—that is, they have 28 or 29 yards on either side of their "gate" or road Before commencing holeing, in many places, spraggs are put up underneath the coal, 6 feet apart, and the duty of the fireman is to see that is adhered to. The men not observing these precautions are liable to be put out of the pit. The holeing then commences, and of the six men employed in each bank, two are employed chiefly at holeing, two taking down the coal, and two filling. The wall of coal is first broken down at the "gate ' or

road-end to a depth of from four to five feet, which gives them what is called a "buttock" on either side (what we call "cut" in Scotland), and this "buttock" or "cut" is worked on "end" to the extremity of their bank, the rails being laid along the face to permit of the tubs following up, and having the coals filled where they are dropped. In dropping the coal only one sprag is taken out at a time, and if the coal does not drop, a shot is put in to drop it. When the coal is worked to the far-end, they then "far-set" their bank. Props are set pretty close to the coal, sprags are again set underneath the coal, and the holeing commences as before. Accidents are few indeed. The number of props used was according to the nature of the roof. If the roofs were bad, they used more props; if good, the fewer. That was left to the fireman entirely to decide, and if a collier did not set up a prop at once, he was liable to be sent out of the pit; and it was necessary that he should have this power, as otherwise his time would have been employed in endless altercations. As soon as the bank has been far-set and the pack-walls put in, they employ leisure time in taking out the old wood; whether broken or whole, this old wood is usually sent to the hill and cut up to make lids or sprags.

The PRESIDENT—The propping is in charge of stallmen?

Mr DRINNAN—Yes. There are two stallmen and two fillers. In some places the holers are employed and paid by the yard of holeing. Generally we set a bank to four men, and the fillers were employed and paid by them. In some places this is done. In Mr Robson's paper, his subject is divided into two heads—danger seen, and danger unseen. With regard to seen danger, it might be left to be dealt with as you suggested in speaking of fire in mines. Where danger is seen it is the duty of the miner to take steps to avert that danger. With reference to unseen danger, I wish to ask Mr Robson whether he was prepared to make any statement as to the number of accidents that have occurred during the year that were due to danger that hadn't been seen, and no steps taken to avert it. It would add to the value of the paper if he were to give us this information about a system of propping in order to avoid accident due to unseen danger. That is about all I have to say. There is one thing

regarding the ignorance of miners. I think it is not a thing Mr Barrowman can fairly charge against the miner in watching their places. The most of the miners when they have been engaged for some time are as competent to take charge of themselves and their places as managers. In this respect their education is perfectly good; and of the accidents which take place, you may safely say that more are due to foolhardiness or carelessness than lack of knowledge—indeed, my experience is that accidents more often happen to skilful miners than to men who are comparatively unskilled and new to the trade.

Mr FAULDS—In Mr Robson's paper under condition (1), page 124, he says, "An idea of safety becomes through time more and more impressed on the minds of those persons interested," &c. Those persons interested may neglect to take means to prevent such falls occurring, but the manager should make it imperative that a sufficient quantity of props be put up to protect the colliers' working places and drawing roads; and by that method, together with the necessary spragging as the author suggests, would prevent such falls of roof and coal occurring. He again says under condition (2), near top of page 126, "The experience gained clearly shows that the remedy for this state of matters ought to be sought in the enlargement of the system pursued," &c. I believe some of the members present agree with me when I say that the means as used generally in our district, with strict discipline, are quite adequate to prevent such accidents. About top of page 129, the President says, "In nearly all cases it is the unexpected that happens"; and at top of page 134, Mr Waddell asks how to guard against the unexpected, and in reply, on same page, the President says, "If we could put up props some of them would hit the plan," &c. With 12 or 15 feet of strong rock roof, as in Mr Hastie's case, the coal was taken out safely, and that which was taken out fifteen years previous was standing without props. In this case would it not be necessary to have some props put up in the working place. Would Mr Hastie tell us what area of roof was standing without props, and what was the thickness of the coal extracted from under this roof. As the President expressed at page 133, we are all at one when Mr Hastie said that the only remedy is by putting up plenty of

wood. At Dalzell Colliery, in main coal stooping, the roof is pretty hard with a rock falling on top of coal, averaging about 18 inches thick. The falling being very deceptive, seldom comes down with the coal: when it does come down it is mostly in blocks. The method adopted is by putting up props 4 feet apart only when the roof is good along face of coal besides those put up along the waste, until the coal is taken down and then other props are put up at similar distances in proportion to the amount of cracks or fissures in the roof. Very little propping is necessary when working the rooms. It seems to me, and perhaps to some of the members present, that those accidents occurring under each of the conditions in Mr Robson's paper, and those mentioned last night by Mr Austine, are chiefly caused by carelessness, incompetency, and insufficient propping. The remedy for these accidents can be had by the execution of strict discipline with competent persons.

Mr ANDERSON—That is an exceedingly strong statement. An accident will never happen again if we can follow the rule of strict discipline, and according to the last speaker, we will have no accidents whatever.

Mr FAULDS—I did not mean that no accidents whatever would occur.

Mr ANDERSON—I thought I was taking the meaning of the words—if there is strict discipline the most of accidents will be prevented. I can agree with what Mr Austine said last night, that if we just enforce the rules we have there might be a diminution. The difficulty is this, as he reminded us, passing along the face, the fireman comes to a place in need of being propped, and he tells the miner to put up props to secure it, and passes on to the next place; but if he comes back in a little, very likely he finds that the man has not done it. At a neighbouring colliery they had a rule that "miners put up sprags not more than 6 feet apart." In our special rules, No. 58, it is stated that "these props or sprags shall be set up at such times and in such numbers and at such points within the working limits as shall from time to time be necessary." Suppose the fireman tells the miner to put up props or sprags at a certain place, and he either neglects or refuses to do so, can we give him in to the Fiscal? or

do we need to go to the inspector and get his sanction to change the rule and state that sprags shall not be more than a specified distance apart.

The PRESIDENT—I don't think you require that sanction; but it is simpler when a limit is fixed by the special rules. You, as manager, have only to say that props or sprags shall be set up, at least, a certain distance apart, and where the circumstances require it they can be put up closer as the fireman may direct. The miners can put them closer still if they wish.

Mr ANDERSON—That is what I wanted to know. I cannot say that I can give any information to Mr Barrowman. One thing that suggested itself to my mind was this—that surveyors and men in charge are not long in one place; but the collier has to work there, and in doing so, relieves some part that allows the roof to come down or the coal to fall over, while they may be a long distance away, and that is something unexpected that happens, I think it is important to have the enforcement of the present rules. We look upon it now as the colliers' duty to set up the props, and I do not think it would be better to say to the collier that you have nothing to do with it. I question if it would be safer for the collier. If we get the firemen trained up not to speak about it, but to cause it to be done, and then having some brought before the Sheriff for neglect, this might be the means of stopping such a system.

Mr ROBSON, in reply to Mr Barrowman—I agree with Mr Anderson as to the reason of so few officials being injured by falls, because they are not so long exposed to new roofs and sides of coal, and falls mostly happen in newly-exposed roofs and sides. That is really why I propose the setting up of props immediately after the roof is exposed, to protect the miners or whoever happens to be near it. It would equally apply to the kind of roof of which Mr Hastie spoke, where he considered the props were not required, because, however good the roof in a place may appear, the portion immediately overhead may be weakened by the next removal of coal, and may become dangerous, and in this way, by having props sets up in every case, accidents would often be prevented. I do not think the question of education affects the principle involved in the paper at all. Mr Barrowman suggests

that if more propping were done, it would lead to the stoops being removed sooner. It is quite possible that might happen in some cases. There are, however, many other things to consider besides propping before anyone can say what is the proper time and method for removing stoops. In answer to Mr Drinnan, I am sorry I cannot give him statistics as to the number who are injured where there is no danger suspected or seen. It is rather a difficult matter. There is a great deal in opinion. One man may say there was no danger seen, another may say he had suspected it. One person may say I will always suspect danger, another may say I will be guided by what I see. I do not quite agree with Mr Faulds in thinking that accidents are chiefly due to incompetency and want of discipline, because it is often very experienced miners who are injured, and however good the discipline of a mine may be—and it never can be too strict—wherever the matter of securing the roofs, &c., is left *entirely* to be dealt with as deemed necessary, accidents are more likely to happen than by following a definite plan. I do not think I can say more than I have said in my paper in reply to anything else which has been brought out in the discussion as far as it has gone.

Mr RONALDSON—With regard to one matter Mr Robson refers to at page 126 "Much good would result," &c., ... "secure." In theory I think that is correct, but what is it in practice? This competent person must make his two or three rounds a-day, as required by the special rules. If his time is taken up by waiting till the places are secured, he might not be able to complete his rounds and something might go wrong in another place, and the question would arise—Why were the visits not made at the proper times? I think the competent person in going round should not, as a rule, remain to see the roof secured; and, as some have said, if strict discipline be maintained—if the miners know that propping must be done at once when the fireman says so, the necessity for the fireman or other competent person remaining to see the roof made safe is not so apparent. But suppose the men won't implicitly obey orders, then have a few of them brought before the Sheriff, and they would soon learn when told to do a thing to do it. If these instructions of the competent person were more strictly adhered to, I am of

opinion that a number of accidents would be prevented. I have observed again and again that if the men want to get their hutch filled, or a piece of coal holed, the thing is put off till an accident happens. Regarding the point of spragging the undercut coal, one would imagine miners had some great difficulty in putting in sprags, or that they would lose a great deal of time in doing so, they have such reluctance in complying with your request if you suggest putting up a sprag, they will "chap" the coal, and ask if it is like coming down, and it is often difficult to convince them that they should guard against unseen danger such as "lipes," &c. If the miners would put up "gibs" regularly whether danger is apprehended or not, many an accident would be prevented. Those who almost daily have to do with accidents cannot but see that these things happen again and again through want of simple precautions. They who neglect to secure their own safety act most foolishly, and a stronger word might be applied to it.

Mr FAULDS—With regard to the delay of the fireman on making his rounds and seeing the men put up props, I think with reference to enforcement of the rules—in enforcing the matter they would get uniformity of work and so obviate the difficulty. If the rules are strictly enforced delay could be overcome, and the work could be made safer.

The PRESIDENT—You will agree that this discussion should be adjourned. Those who cannot attend might send their views in writing, as one gentleman has done, that we may have this subject thoroughly discussed. We are all at one as to the importance of it, and I am glad to see so many gentlemen have so forcibly expressed themselves. It will do a great deal of good. (Applause.)

After a vote of thanks to the President the meeting closed.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING, 9th DEC., 1880,

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON.

RALPH MOORE, Esq., President, in the Chair.

THE Secretary read the minutes of the last General meeting and Council meetings, which were approved of.

The following gentlemen were then balloted for, and admitted as Ordinary Members:—

WILLIAM FREW, Coalmaster, Raploch Colliery, Larkhall.
ANDREW M. WILSON, Agent, Glorrat, Milton of Campsie.
JOHN TENNANT, Commission Agent, Auchingramont, Hamilton.
ANDREW PETTIGREW, Colliery Manager, Stirling Street, Airdrie.
THOMAS ANDERSON, Colliery Manager, Kirkwood Colliery, Coatbridge.
GEORGE ANDERSON, Colliery Manager, Barkip Colliery, Dalry.
CRAWFORD JAMIESON, Colliery Manager, Old Cumnock.
JAMES PRINGLE, Oversman, Govan Colliery, Glasgow.
JAMES HILL, Oversman, Auldhouseburn Colliery, Muirkirk.

Other three gentlemen were then nominated as Ordinary Members, and will be balloted for at the first Meeting.

DR. IRVINE'S SAFETY LAMP.

The PRESIDENT—I have now to introduce to you Dr. Irvine, of Glasgow, who will explain to you a very pretty philosophical contrivance, viz., his lamp, which indicates or detects fire-damp by sound. It is some years since I first saw the lamp, and I am sure you will all be delighted with it.

Dr. IRVINE—By way of introduction to my subject, and in explanation of the principle upon which my miner's lamp is formed, I wish first to show you one or two singing flames. The first singing flame recorded (about a hundred years ago, by a Frenchman of the name of De La Rive) was the hydrogen flame. When a small jet of hydrogen of such a size, for instance, as this jet of coal gas is allowed to burn within a tube of proper dimensions (such as the one now shown), on reaching a certain point within the tube it is thrown into vibrations, the cause of which is variously given. It has generally been said to be in consequence of a number of small explosions rapidly following one another, and in this way setting up a sound within the tube, which, corresponding with an organ pipe, commands the explosions into rythmic regularity in such a way as to make it not a noise only, but a musical sound. My own explanation of the matter is a little simpler. I scarcely think that explosions are necessary to explain the sound. I believe that, as the air is heated within the tube the current produced blows upon the flame, and at a certain point in the tube, where that current is most rapid in the axis of the tube, the flame is thrown into a flutter by the current, and these vibrations are so regulated and fortified by the tube that they give out a musical sound. I have no hydrogen gas, but I can illustrate the phenomena with coal gas. I shall put this tube down over the little jet, and when it reaches a certain point you will find a sound is given out. You will observe a change on the flame too, —the flame is lengthened and vibrates; and if we had the necessary apparatus we could show that it is vibrating very rapidly with perfect regularity, but it is not possible here to have such an apparatus. You will see if I remove the tube to a certain distance up or down, the flame ceases to sound. I come back again, and at that point it begins to sound once more. There (showing)

it sounds perhaps most vigorously of all. Now, this little flame under vibration corresponds exactly with the flutter of air produced at the lip of an organ pipe. The sound of the air on the lip of an organ pipe is a rough sound without any music; but the pipe regulates and fortifies it so that the vibrations created take place with absolute regularity and a musical sound is produced. That this tube does correspond with an organ pipe, I may show you by using another, one of different dimensions, and you will find a much deeper note is given, because it is a longer tube. (Gives illustrations.)

I shall now show you what is called the gauze singing flame, and I believe I was the first to record it a good many years ago. I have no doubt that it had been often seen by others; but so far as I know no record of it appeared; and to show you that such things are often observed and no mention made of them, to-day I happened to go into a place where air and gas are burned together in irons for the purpose of ironing clothes. The manager was showing me the irons, and happened to turn up one of them, and we got a singing sound as perfect nearly as with the flame before you. That sound he had heard many a time but did not understand the cause of it, and I rather think, from a remark by Sir Humphrey Davy, he had seen the gauze flame though he did not describe it. Now, take a rat-tail gas burner, and placing above it at a short distance—some two inches or so—a piece of wire gauze, we get a flame on the surface of the gauze which will illustrate the form in which I first observed the gauze flame. The flame as you see it at present gives out a rough sound. I do not think those at a distance will hear it. It is like a slight blowing sound. I place this lamp glass over it, and immediately you hear this loud note. It is caused by the explosive mixture which is burning on the surface of the wire gauze. The air and gas have sufficiently mixed below the gauze to make it an explosive mixture. It is very sensitive to sound, by properly adjusting it, as I shall show you immediately. When I first observed it, I happened to be making a mercurial thermometer, and some moisture had got into the column of mercury. Thinking to remove it by heating the whole tube and the bulb at the same time, I placed above a gas jet and wire gauze a moderator lamp-glass so as to obtain a smokeless source of heat. To my

astonishment, I got a sound like that you now hear. It was a longer tube I used and so shrill and penetrating was the sound that I was thankful in a very short time to put it out. The note you hear is a much more musical one. As I have said, it is a very sensitive flame, *i. e.*, sensitive to sound. Having removed the lamp-glass, for instance, and properly adjusting the position of the gauze, if I shake my keys you see at every shake it responds by bobbing down, and it does so if you stand at the farthest end of the room and make a hissing sound. That part of it was not observed by me, but, being well acquainted with the subject, I no sooner saw a description of it than I felt sure this sensitive flame would sing at the same moment that it bobbed. In a few minutes I had tried it, and found it was as I supposed.

Returning now to the ordinary gauze-flame, which is not sensitive, and sings continually, I have shewn you it by way of explanation of my lamp. When an explosive mixture of gas and air comes into the lamp, and is ignited at the flame of the lamp, it immediately gives out a sound like that you hear, and thereby would indicate the presence in a mine, &c., of a mixture of inflammable gas and air. There is one thing about the lamp I may mention, so that no one may in any degree be misled,—and it was pointed out to me by your President when he saw it first, —viz., that the risk or chance of a lamp of this sort going out (where the amount of air entering it is very small in comparison, for instance, with the Davy lamp) is greater than in lamps having a large supply of air. Whether this lamp may go out or keep light depends on the purity of the gas, into which it may be introduced. It may be considered troublesome to have a lamp that goes out so readily as this one does, but that is a question on which opinions are different.

If the explosive mixture is free from carbonic acid, it will burn and give the sound you now hear, but if there be a certain admixture of carbonic acid it will go out. No safety lamp is so tenacious as the Davy, but that is because of the large body of flame within it, and it is questionable whether that is an advantage in regard to safety. I consider my lamp safer than the Davy. I now show you the lamp burning as it would in ordinary circumstances; but when I place it in this glass vessel, which represents

a portion of a mine, and supply it with a mixture of gas and air, you will observe the change on the flame as in the Davy, but in addition this clear note is given out. In this specimen of the lamp I have put paraffin oil, but of course any other oil will answer the purpose equally well. The only difficulty about a paraffin flame is that it is very sensitive and more easily put out by shocks and wind. Any flame, in fact, which requires a rapid current to make it burn well is much more easily put out than one with a lazy flame. In regard to the light from this form of the lamp, I daresay a great many will object to it on the ground that it has only a light on the one side. I have other forms in which the light is thrown all round, but I think this the best. I do not think the objection has good grounds, for this reason—a man working with a light does not want it in his eyes; he wants it reflected from the work he is employed on, and we know quite well when you are reading, if your light is so placed as to shine into your eyes, that takes away at least one-half of the light on the book. Therefore, I look upon it that such a lamp ought not to be objected to on account of having only a light on one side. The lamp consists in various parts,—first of all it has the chimney, which plays the part as well of an organ pipe. The window consists of three layers, two of glass with a layer of mica between, so that if one glass should either be broken by a drop of cold water or a blow, the chances are, the mica or the other glass would remain sound. The body of the lamp contains the reservoir for oil, and round it is a cylinder of wire gauze, while at the top of the chimney there is a dome and covering of gauze. Below the flame which is doubly guarded when the cistern is in its place, in order to preserve this disc of gauze around the wick-table as clean and clear as possible of coal-dust, there is a complete cylinder of wire gauze enclosing the oil cistern with space between them, so that the air may easily get in to supply the flame. When the explosive mixture takes fire at the flame of the lamp and burns, it is on this piece of wire gauze round the wick-tube that the effects take place which we have seen in other experiments. The arrangement of the cistern I look upon as a good one, for the miner can replenish it without any risk. For instance, he might have it in this condition (showing the cistern out) and the lamp

will go on burning and be perfectly safe. That is a quality which I think may be considered of use. Dr. Irvine, after fully illustrating the operations of his lamp, said if it were found to be practical in other respects, it would be a very useful thing indeed to have such a sound given out. It would enable not only the miner but all in the neighbourhood to ascertain the condition of the mine.

The PRESIDENT—Dr Irvine has shown us two things to-night. In the first place, he has shown us a very good safety lamp. Speaking of the lamp itself, you will bear in mind that in Dr Irvine here we have a purely scientific man, who is able to explain to us the power of flame, the principles of light. His remarks as to the amount of light given in this flame over a flame shining all round are well worth noticing. I must confess I have a liking to a flame which does show all round. I think I once said that to the doctor before, and he proposed by means of chrystals to show all round.

Dr IRVINE—Yes, I made the lamp by means of mica to show all round.

The PRESIDENT—But what the doctor says is very clear—that this lamp shows light where the man works in a very distinct manner. Then, he also explains a very beautiful arrangement of the lamp itself, a means of providing it with oil with safety—in fact, the supplying of oil to the lamp has nothing to do with the exposing of the light to the atmosphere. That is a very valuable thing, and I must admit I did not see it so clearly when I saw the lamp before as I now see it. If there was nothing else than the lamp itself, it is worth our looking very carefully into it. Then there is another thing, it detects gas by the sound. I think when Dr Irvine first brought out this lamp be had an idea that it would be useful for a fireman detecting fire-damp, or it would be useful to be placed in some place and kept burning where gas was likely to collect. I dissuaded him, however, from attempting to make money of the instrument in that way, and I still hold the same opinion, viz., that in that respect it is not of much use; but supposing a miner is working and he suddenly comes on a feeder of gas, which does not attract his attention, but the sound from this lamp at once brings it under his notice, and he can take his lamp into a better atmosphere. I

consider that is a very great matter indeed. I must say I am exceedingly pleased with the lamp. It is a most ingenious invention, it is a philosophical invention, such as we might expect from a mind like the doctor's.

Mr RONALDSON—Can Dr Irvine inform us what proportion of gas to air would emit a musical sound?

Dr IRVINE—As soon as ever the gas reaches about one to six, it will give out this warning, and from there on to one to thirteen or fourteen. I mean one of gas to thirteen or fourteen of air.

Mr SMART—Do I understand that if this lamp as it stands now were taken into a place where there was fire-damp, it would emit the same sound?

Dr IRVINE—Yes, but as I explained before, the only difficulty is that the lamp, where the supply is limited, will occasionally go out, and if carbonic acid gas is mixed with it that will render the lamp more liable to go out. When there is any impurity that makes it more liable to go out, and indeed no lamp holds in like the Davy when there is any impurity in the atmosphere of the mine.

The PRESIDENT—I suppose it is only when the mixture entering the lamp is lighter than atmospheric air that the sound is produced.

Dr IRVINE—Of course fire-damp is lighter. When it is mixed with light carburetted hydrogen, it might be lighter than atmospheric air.

Mr SCHUMAN—A flame burning within an enclosed vessel would accumulate a surrounding heat, and the question is, would the drawing in of cold atmospheric air under pressure through small openings such as wire netting not record a sound on the method of a common whistle?

Dr IRVINE—No, sir; although I scarcely understand the question.

Mr SCHUMAN—Suppose it were not fire-damp that would pass into the burning lamp but simply caloric under other modifications, such as very warm or highly-heated atmospheric air, that would be drawn into the tube of the lamp and pass through the wire gauze, would that produce the sound?

Dr IRVINE—Oh, no. However, if you put a piece of wire gauze into a tube somewhere near to the centre of the tube, and then heat it with a flame and remove it from the flame, there is a singing sound given out. I suppose it is that to which you allude?

Mr SCHUMAN—Yes.

Dr IRVINE—But the wire gauze in this case never gets sufficiently heated except with fire-damp. It is really the burning of the fire-damp on the surface of the wire-gauze that causes the sound. There can be no doubt about that, if you judge of it by analogy with the other singing flames, viz., that in this case it is the vibration of the flame and not the heating of the fire gauze.

The PRESIDENT—What if there is a mixture of carbonic acid gas so as to make the gas of the same density as atmospheric air?

Dr IRVINE—I never tried that in exact proportions, but I have no doubt that if reduced one-seventh, according to Sir Humphrey Davy, it will be sufficient to prevent an explosion, so, of course, in that case, the lamp would not sing. I do not think it would make any difference until it reaches one seventh, and that is a point at which no explosion would take place. Up to that point, I think the lamp would sing. Up to that point, the atmosphere is heavier than common air. I have not made any experiments.

Mr SMART—My idea of the question of Mr Schuman was this: Would the singing sound be produced with any other gas if of the same density as fire-damp, comparatively? Of course we know that fire-damp is about the half of common air, so if it was introduced into any other gas of the same density, would it have the same sound?

Dr IRVINE—Any inflammable gas mixed with air. You see in this case I have illustrated it with a gas much richer than carburetted hydrogen, but with any inflammable gas, sulphuretted hydrogen for instance, the same sound will be produced if the mixture is explosive. The sound is produced by the vibration of the flame, and that vibration is regulated by the length of the tube, by, in other words, the organ pipe.

Mr MARSHALL—How long would the lamp burn with safety after first emitting a sound?

Dr IRVINE—I consider it would burn with safety for any

length of time except, I suppose, it could be exploded by burning it till it was red hot. I think this chimney might be red hot before there would be any risk.

Mr MARSHALL—In the experiment you showed us the flame got so large as to cause it to blaze up there?

Dr IRVINE—But it would very soon smother itself out at that rate.

Mr GARDINER—How long might the lamp burn before the gauze under the flame got warm enough so as to be useless and at once prevent the passage of the flame?

Dr IRVINE—I have used it many and many a time; I have had it singing for hours, and I never once had an explosion. I never saw it burst, so that on no single occasion has the flame passed through the wire gauze; and I believe you could burn it for any length of time, until the chimney is red hot.

Mr SCHUMAN—I suppose the size of your glass tube is pretty well proportioned to the size of the flame. Suppose you had a larger flame you would require a broader chimney to produce the sound?

Dr IRVINE—You would require a longer tube probably. The size of the flame, the size of the disc, and the length of the chimney have been simply matters of experiment with me to see what was best, and I reduced it to the length which I found to suit best. It is the shortest I have been able to get a satisfactory result with; it has been a matter of experiment, and I had to make a great many.

Mr SCHUMAN—You have not yet reduced the dimensions and shapes to mathematical or formulæ precision, because I think the results will vary if the sizes are changed.

Dr IRVINE—It needs a good deal of trouble to arrive at the best size. That is not the only size and shape I have made it.

Mr J. S. DIXON—I wish to ask two practical questions. The lamp has been sometime in its present form, I understand; has it ever been practically used in coal mines, and what is the cost of it?

Dr IRVINE.—You have hit the mark now. I may just say I never sold a single lamp for the reason I never had the face to ask the price which they cost for them. If the lamp were

considered a good one, and brought into use, then I daresay they might be reduced in price. I do not think they could ever be made for 7s 6d, because there is a great deal of work about them which is not about an ordinary lamp. I do not think they could be made for much under a pound, but I never asked a Birmingham manufacturer. If they could be made sufficiently cheap, I dare say they would be sold, but it has not been much in my way to push the matter commercially. That has been my difficulty.

Mr DUNDAS SIMPSON.—Am I right that these lamps would burn any kind of oil?

Dr IRVINE—Any kind of ordinary burning oil.

Mr DIXON—Mr Ronaldson asked a question I am not distinct about, viz., what is the lowest proportion of fire-damp mixed with air that would give out this sound?

Dr IRVINE—I think I said 13 or 14 of air to one of gas.

The PRESIDENT—I was going to ask the doctor to allow his lamp to stay here so that the members of the Institute could see it at leisure.

Dr IRVINE—I would be very glad indeed to do that, but I have promised to send the lamp up to the Accidents Commission. As soon as I get it back, I will be glad to let you have it.

Mr DIXON.—I would like to ask the opinion of our President as to the adaptation of this lamp bottom to an ordinary Davy or safety lamps of any kind, so that the miner might fill his lamp while at work without having to go to the fireman's cabin. I think that is a very nice arrangement indeed. I am very much pleased with it.

The PRESIDENT.—If there is no other gentleman wishing to speak, I think we will close the discussion at this time. In regard to Mr Dixon's question, I admire the construction of the lamp very much, but I should not like to give it as my opinion that it is the best. After I examine it thoroughly I will be prepared to give my opinion in regard to it. It seems a most ingenious instrument,—first, as a lamp; it is a very beautiful safety lamp independent of its qualities as a singing flame, worthy of attention if it could be made cheaply and burn as well. I look upon the other as secondary to a certain extent, because it is

not very often we do find these things very practicable; still, if it is a good safety lamp and in addition is a mode of detecting where fire-damp is coming from, the side or anywhere, it is a very valuable addition to the lamp. Without committing any of you, I think you will permit me to say we are very much obliged to Dr Irvine for coming before us and giving us such a very lucid description of the philosophy of the sensitive flame and of his lamp. I admire the simplicity and beautiful arrangement of it; and I have no doubt but that if some commercial gentlemen were to take it up it would be made at a cost which would bring it into use. I think it could be made much cheaper than the Doctor imagines. However, that is a commercial question. We are very much obliged to Dr Irvine for coming here. (Applause.)

Dr IRVINE—I beg to thank you for the kind reception you have given me. I have had very great pleasure in showing the lamp. As your President says, it has been a hobby with me, I did devote a little care in the way of the construction, although sometime has gone past without its being adopted. I hope it may yet be adopted. When the Home Secretary was here he did not see the lamp, and I wrote to him saying I had a lamp—or rather it was up in London at the Engineering Exhibition. He wrote me back as usual simply acknowledging my letter and saying he had sent it on to the Accidents' Commission, and I had a letter from the Secretary of the Commission requesting that I should send it up, and I promised to do so.

THE SOUTH STAFFORDSHIRE THICK COAL.

BY ROBERT CALDERWOOD.

The Secretary, in the absence of Mr Calderwood, read as follows:—

IN writing this paper on the "Ten-Yard Coal of South Staffordshire," it is my intention to give more of a descriptive than an argumentative paper. Of course, should I be unable to attend the January meeting, I will be glad to answer any questions members may put through the Secretary.

Referring to the general section (Plate IX.), the ten-yard seam I take to be the upper part of the coal measures thrown together, and, geologically, occupying a position immediately between the permian and silurian measures, the lower part of the coal measures being awanting. At Dudley, in the famous coal field of the Earl of Dudley, near the out-crop, there is only about 20 feet between the bottom of the coal and the silurian limestone. In other parts of the field, the distance is greater, and the famous Stourbridge fire clays come in. In several parts of the field, there are various workable coals, both above and below the thick coal, mostly associated with beds of ironstone balls, either over or under them. In the Stourbridge neighbourhood, the coals under the thick coal are not often of sufficient quality or thickness except in conjunction with ironstone or fire clay.

The heathen coal, seven feet under the thick coal, has a bed of rich ironstone balls (Gubbin measures) over it, and is sometimes worked for this ironstone. Ten yards under the thick coal, is the lower heathen and whitestone, which, when it is worked, is always for the ironstone. The new mine or sulphur coal is sometimes worked for itself, but more frequently for the fire clay.

The only workable coal above the thick coal is the brooch coal (40 yards above), which usually has a very rich ironstone under it. Immediately over the thick coal are the ten-foot ironstone measures, thin clay bands from 1 in. to 3 in. thick, and usually got in the thick coal wastes.

The thickness and quality of the "Thick" coal varies greatly over the field. Thus at Netherend Colliery, near Stourbridge, and the collieries in the immediate neighbourhood, the coal is 11 to 12 yards thick, including partings, which amount from 10 to 12 feet. (Plate X.) It is of inferior quality; except the top 7 feet and bottom 5 feet. About a mile north-east of this, it is 12½ yards thick, perfectly clean, and of good quality; and at the Earl of Dudley's opencast workings, near Dudley, it is nearly 20 yards thick and quite clean. To the south and south-east of Netherend, and near what is reckoned the boundary of the coal field, the coal gets worse, and more split up. At Hayes Colliery there are 18 yards of rock between the top and bottom

coals. South and south-west of Stourbridge, the new red sandstone comes in, but no attempt has been made to prove the coal under it yet.

Hitherto, the thick coal has been found at moderate depths, but recent researches have proved a large area of splendid coal near to Birmingham, under the basalt, where no coal was supposed to exist, Mr Henry Johnson, M.E., of Dudley, having played no insignificant part in the discovery, Sandwell Park Colliery, four miles from Birmingham, the first discovery, being entirely due to the exertions of this gentleman. The colliery is 430 yards deep, with a perfectly clean coal 8 yards thick. Hampstead Colliery, in the same field, 620 yards deep, with an 8 yard coal, perfectly clean and good.

With this short description, I will proceed with the Modes of Working, &c.

MODES OF WORKING.

The old mode of working (which is still in operation at several collieries) is called "rib and pillar," the coal being got the whole thickness. When the pits (which are always sunk in pairs) were sunk, a pair of gait roads were driven in the Slipper and Sawyer Coal to the nearest boundary, and a side of work opened off, say two stalls on each side of these gait roads, by driving a stall 9 yards wide at right angles to the gait roads, along the boundary rib, in the Benches and Slipper Coal, a row of small cogs, or men-o'-war as they were called, being built up the centre to support the coal above. When this is driven up say 35 yards, the work of cutting in is commenced, the first cutting being along the boundary rib, a cog taken out and the coal dropped, ready for loading. Another stall parallel to this is driven up in the same way, and pillars 9 yards square, cut off into the first stall, the openings between these pillars being used as "Bolt" or loading-out holes. While the coal is being loaded out of the first stall, the work of cutting upward goes on, and so on until all the coal in the stall is got, or until the coal broke down from the weight of superincumbent strata brought to bear on this wide opening, a considerable portion of the top and best portion of the coal being buried under the debris. This is a very dangerous mode of working. The collier in cutting the upper portions of the seam,

requires to stand on a plank or ladder, perhaps 20 feet above the floor of the mine, when a sudden bump or crush (which is no rare occurrence) may take place, and precipitate him to the ground, with perhaps a considerable amount of coal on top of him ; besides if the mine gives off explosive gas, the only provision to clear it off is a small head, driven between intake and return, about seven feet from the top of the coal—an old Staffordshire idea being that the less air in the stalls the better. This idea I am glad to say is dying out, at least amongst the managers. While the coal is being got in the first stalls another side of work is being opened out, a fire rib being left between. After the coal in the first stalls is all got, should an opportunity occur, the pillars are robbed. By holing off the sides, and using a little powder, as much coal is brought down as keep the loader on sometimes for weeks, but frequently the roof breaks down before this can be done, or the stalls may have had to be dammed up for fire stink. When the pit or part of it is worked out, these ribs and pillars are got by driving roads through the old waste.

The next mode of working is what is called "got on knobs." The gait roads are driven out to the boundary and stalls opened in the same way as in rib and pillar, but without the rib. It is a stoop-and-room working, with the addition of gait roads, driven to the boundary, and the stoops formed on the way coming back, instead of going forward.

I may mention in passing, that the work done in these two systems, is by stint, the collier having to do so much holing or cutting, for a day's work, all drink ($\frac{1}{2}$ gal. ale per day), tools, candles, and fire coal being found him. When the pit is let to a Butty collier, he pays his men in the same way.

This brings me to what I consider the most economical and safe mode of working thick coal.

The working is conducted in two divisions. Gait-roads are driven in the top 7ft. (Plates X. and XI.), and the work opened out in as long a face as you choose (there being no danger of fire stink in this working). The stalls are "thurled" 5 yards wide, from one gait-road to the other, in the "white" coal, and the spires, roofs, and 6 inch coals logged up. The holing is done long-wall fashion, all along the face, in the heath coal

bat, and the white coal taken down, another row of cogs are built and the holing continued. When two rows of cogs are on, the getting of the coal in the back row is commenced by holing in the top of the cog and fetching the coal down with a crowbar. While the coal is being "backened" out, short trees are set on foot-lids to support the roof. When all the coal is drawn out, these trees are drawn, and the roof allowed to break, the 10-foot ironstone being picked out as opportunity occurs. Before the bottom coal is got, the top coal waste should be allowed to settle for two or three years. When it is decided to get bottom coal, gait-roads are driven out in the Slipper and Sawyer coal (Plates X. and XII.), 6 ft. wide and about 25 yards apart, with cross-roads about every 50 yards. While the roads are under the "quick" or where the top is on, they do not stand well, and require constant timbering until the creep is past. When the roads get under where the top has been got, they stand better, as the creep is not so great. When the roads are driven out they are thurled 5 yards wide in the Slipper coal, and cogs 9 ft. square and 6ft. apart built next the rib. These 6ft. openings are called the "bolt" or loading-out holes; along the front of these cogs, and next the face, the Sawyer coal is cut and dropped, making a road 5ft. high along the face for the tub. The holing is continued in the Slipper coal, and another row of cogs built, the Sawyer coal cut in and the tub transferred to the face side of this row. While the holing for another row of cogs is going on, the back row is being drawn. First, one cog is taken and holed on the top of the building, and as much of the coal got down as possible (perhaps 7 or 8 feet). As each measure of coal is got down, it is loaded out and the rubbish allowed to lie, which raises the floor, and allows the man to get within reach of his work, besides being able to set timber on this rubbish should it be required. When a third row of cogs are put on, the bolt holes of the second road are cut through in the Sawyer, and the getting of the top portions of the first row proceeded with, until the Heath or topmost coal is reached. If the bat above this coal is strong enough, the whole of the coal is got out; but should it prove weak, this coal is often lost, as should it and the bat break together it is buried by the loose top coal gob. I may say that these high wastes are never gone

into without being examined or "felt" by a pricker, *i.e.*, a long stick, 12 to 20 feet long, with a spear and hook, not unlike a canal boat-hook. With this pricker, all loose pieces can be pulled off, and the general safety of the place ascertained; also, when coal is ready to come, and it would be unsafe to bring it down with a crowbar, this hook is used with great effect.

Before leaving this part of my subject, I may say that no recognised size of block is in use in the various collieries; some collieries being laid out in 40 to 50 yard blocks, with as many as can be got in line. When a case of fire stink occurs all the stalls that are connected require to be dammed up, and a fire rib cut off to open new work. For myself, where I have had an opportunity of opening new work, I have adopted a modification of the panel system, never driving more than two roads together, and not more than 25 yards apart, with provision for separate ventilation if necessary, leaving a block sufficient for other two stalls between this and the next two. By this method I reckon that by quick working I will be able to nearly prevent fire stink, and should it occur it will only affect two stalls instead of a whole row. These two stalls can be dammed up and left until the stink is gone. I have worked one colliery on this principle for two years, and have not fire stink yet, while in another colliery under my charge, with larger blocks, we are seldom many months free from it.

FIRE STINK OR BREEDING FIRE.

The gases given off by slow distillation from heat produced from friction, caused by the pressure of the superincumbent strata, assisted by the chemical action of the atmosphere on various salts in the coal and bats, more especially the Heath coal bat and veins (salt-bat). These gases have been described by some as the effect of spontaneous combustion. I think they are due to a purely mechanical, assisted by chemical action.

The first gas given off is carbonic acid gas, and although in the wastes there is always more or less of this gas to be rendered innocuous by ventilation, when it overpowers the ordinary ventilation there is almost sure to be fire breeding, and this gas is given off as a preliminary. The only remedy, if it is not too far gone, is a plentiful supply of air, if the affected part can be reached, or

a good run of gob will sometimes effect a cure, that is if the gob is old and finely broken up it will act as dam against the affected part, and prevent either air getting to, or gas issuing from it.

When the combustion has gone so far as to give off sulphuretted hydrogen or carbonic oxide in any quantity, if a plentiful supply of air aggravates instead of modifying, the sooner the work is shut up the better, as it will very likely burst into flame. By closely shutting up, the latent fire will disappear for want of oxygen.

I have had cases where a good supply of air has completely overpowered the "stink," but in others it made it worse; yet I contend that a good ventilation and quick working of the coal will do more to prevent fire, by keeping the place cool, and carrying away the gases as they are given off. Of course I do not mean that where heaps of slack and carbonaceous shales are left in the wastes, which is often the case where the partings are many and thick, that fire can be altogether prevented; but by the quick working and throwing in of the non-combustible argillaceous shale, and keeping the coal in process of being got perfectly cool, not merely by ventilation sufficient for men and horses, but by something more, a great many gob fires might be prevented.

It has been said that decomposition of iron pyrites is the main cause of gob fires, but in the Sulphur or New Mine Coal, which contains 10 to 15 per cent. of sulphur, against 2 per cent. in the thick coal, there never is such a thing as gob fire.

Fire-damp is seldom met with in any appreciable quantity, except in opening out maiden mines. A few minor explosions have occurred in the district, but with the exception of Homer Hill explosion in 1867 (13 killed), any other explosions have been small. Sometimes sulphuretted hydrogen is mistaken for fire-damp; and, from experiments made by Mr Williams, of Dudley, carbonic oxide, under certain conditions, has contributed to explosions.

With these crude and hastily written remarks, Gentlemen, I leave myself in your hands; and, perhaps, in endeavouring to answer questions from some of you, I may learn more than I have been able to explain.

The PRESIDENT—This very valuable paper will afford great room for discussion, and after you have read it carefully, I hope to have a good discussion upon it at next meeting. It is a very remarkable seam and the paper describes it exceedingly well.

Mr GARDINER—When may we have the printed report of the paper?

The PRESIDENT—That will be put in your hands as soon as possible before next meeting.

DISCUSSION ON MR ROBSON'S PAPER ON "ACCIDENTS BY FALLS OF ROOF AND SIDES."

The PRESIDENT, by way of opening the discussion on Mr Robson's paper, said perhaps they would allow him to read a few remarks of his own on the subject:—During the last year I ascertained exactly the proportions of coal worked in my district by stoop-and-room in the solid, by stooping, and by long-wall, and the number of accidents—fatal and non-fatal—by "falls" where the various systems were pursued. These were 26 persons killed and 115 injured—in all 141. They occurred as follows:—

One person was injured in solid stoop-and-room for every	90,000	tons of coal raised.
One person was injured in stooping for every	87,000	,,
One person was injured in long-wall for every	73,000	,,

That is to say, the stooping is safer than long-wall as 87 is to 73, and it is very nearly as safe as stoop-and-room in the solid. Now, when we consider that in a lift of a stoop, say 20 yards by 5 yards, there will be from 400 to 600 props set up and drawn again, it will be seen that if these are set up for the safety of the persons it must be a very bad roof; but the object of setting them up is not altogether for purposes of safety, but also for the proper carrying of the roof while the coal is being removed. If fewer props were put up there would be a greater strain put upon them, and more would be broken by the weight, and hence the

economy of putting up more in order to distribute the weight evenly, and to allow of their being got out whole to be used again. But you will see that in this very act of putting up plenty of wood greater safety to the men is obtained, for every one knows that stooping—where the men work along a broken edge on one side—unless very carefully looked after, is more dangerous than either of the other modes, and yet we have these results. It must be known to many of you who have twenty years' experience in stooping that there is a great change in the economy of working pillars to what prevailed then, and this is principally due to the more correct application of propping. At that time, as most of you are aware, pitwood cost from 4d to 6d per ton, whereas, now it is in some instances not more than 1d and seldom exceeds 2d. This result seems to be a striking proof of the benefits of the system proposed in Mr Robson's paper: that we should not depend wholly upon the skill of the workmen to judge of the state of the roof; but, in addition, that props should be set at stated intervals as the work advances. It is clear that the present system stands in need of improvement. Assuming that the stooping is carried on under an improved system it is reasonable to expect that if the solid and long-wall were under the same we might reduce the 119 which now occur in these operations to a smaller figure. I scarcely think, however, that this result will be attained without the employment of a special class of experienced men to be responsible for the propping instead of leaving it to be done by the ordinary miners. These figures, continued the President, are very remarkable. I must say that I was a little struck by them myself, especially when we consider that this most dangerous work of stooping is actually safer than long-wall and very little different than stoop-and-room. I do not think that many of us were aware of that.

Mr MacCreath—Have you made a comparison of the number of tons put out by means of long-wall, stooping, and stoop-and room? If you take the number of men employed instead of the number of tons put out, would that affect the comparison?

The President—No doubt it would.

Mr MacCreath—Would it still remain that the stooping was safer than the long-wall?

The PRESIDENT—Yes; I think it would still remain that stooping was safer than long-wall. The number of tons is after all the correct mode of taking it,—the number of tons raised per life lost or per person injured; because what is wanted is to get out coal by the fewest number of men; and hence when coal-cutting machines are more generally employed, and more machinery is employed for other underground work, we may expect fewer accidents while raising the same quantity of coal, because fewer men will be exposed to danger.

Mr LAIRD—Would you state the proportion of men killed in the working places and working roads?

The PRESIDENT—I have that also. There were 22 at the face and 4 on the roads. Assuming that there are 20,000 miners employed at the face and 9000 underground, but not at the face, then the fatality among the miners is 1 in 909, compared with 1 in 2250 on the roads, or nearly $2\frac{1}{2}$ greater in the former than in the latter.

Mr LAIRD—Were these in the drawing roads of the long-wall and stoop-and-room?

The PRESIDENT—I tried that too, and there is not much difference in regard to the roads in the one system and the other, although, in point of fact, there were no fatal accidents on the roads in stoop-and-room last year, while there were two in long-wall roads.

Mr LAIRD—Was the stoop-and-room, embraced in your statistics, of the same thickness as the long-wall?

The PRESIDENT—As to that, the thick seams are not generally worked by long-wall, so I should say the seams were thinner in the long-wall than in the stoop-and-room.

Mr LAIRD—Hence there would be more coal produced from the stoop-and-room.

The PRESIDENT—Yes, you are right.

Mr TELFER—Mr Robson's notes on Falls of Roof and Sides is one of the most important papers we have had before us for discussion. When we consider that in our own district during the last year 50 per cent. of the fatal accidents in mines were caused by falls of roof and sides, the question naturally arises: could any of these accidents have been prevented? Mr Robson suggests, in order to

reduce the number of them as far as possible, it is desirable to consider the practicability of supporting the roof and sides on a definite system irrespective of appearances of safety. I believe such a system would have good results. We are all agreed as to the necessity of more or less propping in all mines for the safety of the workmen; but we have had few expressions of opinion as to who are the proper persons to do the work. It is the prevailing system in our own district that the propping at the working-places is done by the collier, and it is also the general opinion of oversmen, firemen, &c., that the collier is the proper person to do it; but the fact that in the North Durham district,—where the propping is done by deputies, less than 36 per cent. of the fatal accidents are caused by falls—certainly tells against our system. Possibly the smaller number of accidents from falls of roof in that district may result from the nature of the roofs as much as from the system of propping. For the purpose of thoroughly investigating the various systems of propping in all the English districts, we should send deputations of our members. This is the only way we could get reliable information on the subject, which would be of the greatest importance to all the members of the Institute.

Mr Beith—In the October Transactions (p. 129), our President puts the question whether the props should be set up by the colliers or men for the purpose? The few remarks I make will be confined to stooping. It is now fully two years and a half since we commenced to stoop at Backmuir, No. 2. At first we let the stoops on a three months' contract, and gave besides so much per tree for the drawing of the props, but after a trial for three months we found we did not get on as well as we expected. It was then suggested that we should appoint competent parties to put up the trees. We commenced that system, and ever since then, I am happy to say, we have got on well. We have lost very few props, never had any accident, and have lost no coal; so, in reply to the President's question, I think we should have men specially set apart for the purpose of putting up trees and drawing them.

Mr Faulds—To refer also to some remarks by the President, he says the work should be done on some principle which would secure uniformity. The method generally adopted at present, I believe, is that the fireman goes round the working place, and,

while making inspection for fire, he also makes his observations about the places as to safety, and marks where trees should be put up. When he makes his second inspection, he finds the props are put up in some places, and in other places they are not. Well, in that case, he has only to remain in the place until he sees that the prop is put up. The collier may have an excuse; he may have a bit to hole or a hutch to fill, but it is the fireman's duty to see that that man puts up the prop before leaving his place. Similarly in the long-wall. I think the only difficulty in connection with the propping is at the stooping. As Mr Beith says, there are two ways. It has been tried by roadsmen or men set to that work alone, and it has been tried by contractors at so much per tree or so much per ton. From my own experience, I have found it to work both ways very well. It only requires some attention and care on the part of the collier, firstly; the fireman, secondly; failing both, I think it is the manager's duty to see to the propping being secure. I think stooping is a most difficult question; as to the solid workings and long-wall, on the other hand, I think there is no great difficulty with the present oncost, and seeing that they are properly treed both by the colliers and the firemen.

The PRESIDENT.—Might I remark, in reference to Mr Faulds' remarks, that the facts are against him. We do want something to make long-wall safer, because it is the least safe.

Mr DIXON—In long-wall I am almost certain in saying there are accidents from bursts from the faces that do not take place in the same way in ordinary stoop-and-room working in the solid. I think that is an element in regard to these statistics that should be noted.

Mr RONALDSON—Regarding the point of the comparative safety of long-wall and stoop-and-room, that was already discussed, and I gave statistics regarding the comparative safety of the two, and everything went to show that long-wall was the safer of the two. I did not base these statistics on the output but on the number of persons employed, because as a rule the thicker seams are worked stoop-and-room, and hence the greater output per man. As far as my judgment goes, taking the output is not the correct way of comparing the two, but rather the number of per-

sons employed. I know that in the Western District, statistics go to prove that long-wall is very much safer than stoop-and-room.

The PRESIDENT—Will that be owing to the seams being thicker than our coals?

Mr SMART—Or the roof different perhaps.

Mr RONALDSON—I am just giving the facts.

The PRESIDENT—Perhaps it might be well to ascertain the number of persons. There might be something in it.

Mr GARDINER—The figures given by the Chairman are what I was going to ask if any one present could give. The miner or collier is supposed to be a qualified person to keep a place and take that responsibility upon himself. Managers, as a rule, do not make inquiries as to the collier's abilities when engaging him, but takes it for granted that he is able to attend to the securing of his place. That I consider is a fault. I wonder how the list of injured of twenty years ago would compare with the present day?

The PRESIDENT—There are fewer falls now per number of persons employed and per ton raised. I had occasion to go into that some time ago, and we found that in the year 1860, for instance, the number was much greater.

Mr SMART—I think we are all very much indebted to Mr Robson for this very valuable paper. There is no doubt that to every one engaged in mining, having any charge of the working department, the proper propping to prevent falls of roof is a source of great anxiety to him; there is no doubt also that whatever care may be taken accidents will happen. Our legislature has wisely brought the matter under cognizance and passed an Act compelling us to see that every road and working-place is safely secured, and our industry is fenced about with the special rules laying down the duties that devolve on the several persons employed who are to see that the thing is thoroughly done and to the best of their ability. Still, with all these things, we have accidents happening, and I suppose will have. I think the gist of Mr Robson's paper is that some rule should be laid down as to a regular system of propping. Now, for my own part, I do not see how that could be readily defined. It is well enough known that we have roofs of all descriptions, that in many instances in our main road roofs we arch them with brick for safety. If there is anything to fall,

we brush them to the rock or make them safe with timber. Then we have all the different phases of roof. In places we have a roof that has to be supported by props and straps, almost skin for skin, and there is every phase of these friable rocks met with up to the hard sandstone. It is, therefore, a very difficult thing to lay down a hard and fast line as regards propping. I know it is a thing that we are all very anxious for, viz., that roofs should be made as safe as can be, and I do not think there is one single individual that would grudge either timber or any other material in the working of his colliery so that the safety of the lives of those working in it might be secured. (Cheers.) At the same time, there is one thing that must be looked to, if a hard and fast line were laid down,—if we were required to prop all our places at either a foot or a yard, then the econominal question comes in, would the working of coal pay? Timber, of course, costs something,—these things cannot be done for nothing. Now, if a man has a roof with a good solid rock overhead, he may have other difficulties as regards water or something else so that he is able to compete with another man, who has a friable roof and has to timber from end to end, and if a hard and fast line were laid down that he had to timber the workings whether solid or not some works would require to be abandoned. I know the object of such an Institute as ours is to advance the economical working of coal. We try to introduce different systems, and to advise each other as regards machinery and other points; and I think it is our duty also to endeavour in such a question as this to advise with each other in the same way. We all know how very serious these falls of roof are. The propping, of course, is entirely left to the judgment of the collier, and the men in charge at the working faces, and the roadsmen in the roads; a secret "lype" takes place, and down comes the roof on the top of some one. Of course, had that been seen previously, it would have been guarded against, but in many cases it is a secret cause that does it. I recollect, in the case of an accident from a fall, of a Highland policeman coming into us for particulars making a very innocent remark: "Hoo had she no a stick below it?" (Laughter.) We all know what we would do if these things were apparent; but, of course, they are left entirely to the judgment of the man who has the charge; he is supposed to go his

rounds regularly and constantly, and whenever a defect is found in the roof he has to see it is made secure. Of course, it is left to the judgment of some one; still, I do not see how any hard and fast line can be laid down regarding propping, and I think it may be wisely left to some one in authority in the colliery.

Mr FAULDS—Our President has given the proportion of the killed and injured to the tons raised. I was always under the belief that long-wall was the safer of the three modes of working, but, according to our President's statement, it appears it is the least safe of the three. I think there may be something in what Mr Ronaldson says, viz., that in the Western District there was more safety in long-wall. The reason perhaps is that the seams in the Western district may be thinner than those worked in the Eastern district, consequently, they will compare more favourably as regards the stooping and solid, and it is my belief that the long-wall in the Eastern district may be thinner. Of course, in that event, it will cover a greater area, and consequently have longer roads.

The PRESIDENT—Yes, but there is one point Mr Ronaldson in making his calculation ought to consider, viz., the number of men employed to the quantity of tons raised. For instance, it may happen that there are more men employed in the Western than in the Eastern district per ton of coal raised. In that case it is possible there may be more men employed per accident, and so by the different comparisons,—the one being the tons of coal raised and the other taking the number of men employed per accident,—may make a difference. That I have not gone into exactly, but I shall do so before next meeting, and add it to the paper.*

Mr FAULDS—That will show it much better.

Mr LAIRD—Perhaps, Mr President, you will ascertain what was the proportion of colliers to brushers killed in the long-wall.

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* As nearly as can be made out there were in the Eastern district of Scotland, in 1879, 17,907 men employed in long-wall, and last year they raised 6,039,089 tons; in the solid stoop-and-room there were 8,135 men and 3,346,478 tons; in stooping there were 3,247 men and 1,915,000 tons. The accidents from falls of roof and sides were:—In long wall 82, being 1 for every 218 persons employed; in solid stoop and room 37, or 1 in 219; and in stooping 22, or 1 in 147. J. T. R.

The PRESIDENT—Yes, I can do that also. I am not speaking to the killed alone but to the injured also.

Mr MACCREATH—Possibly Mr Ronaldson may be able to tell us whether he knows if the roof of stoop-and-room in the Western district is worse than the roof of stoop-and-room in the Eastern district. What I have seen of the stoop-and-room workings in the Kilmarnock district, the roofs appeared to be worse than what I have seen in the Eastern district, but of course my experience in that way is limited, compared to that of the Government Inspector.

Mr RONALDSON—My experience is also limited, because I have not had such a good acquaintance with the stoop-and-room roofs of the Eastern as of the Western district. Therefore, I am hardly in a position to make a comparison between the two districts.

The PRESIDENT—If you were to make a comparison, probably the figures might agree.

Mr DUNDAS SIMPSON—If you go to Coatbridge and go through the Glasgow district, the roofs are invariably bad, and the seams are from 2 ft. 10 in. to 20 in. They have very bad roofs.

Mr SMART—When you made a remark about the long-wall, showing a great discrepancy as compared with stooping and stoop-and-room, my idea was, a great deal was due to the brushers. I know a very considerable amount of accidents happens to brushers from their incapacity, as in many instances they are not very experienced men. In addition to the constant creeping weight on the coal in long-wall, if the men are not careful in spragging it, there are sure to be more accidents thereby.

Mr HOGG—I expected to get a good deal of information from this discussion. I think there should be some hard and fast line laid down in every seam, and at certain distances there should be trees put up in the roads as they are being driven. If the roof is pretty good, the distance could be three feet; if not so good, two feet, and so on. There should be a rule for every seam. Let it be adopted and carried out by the miner, and let the fireman and roadsman, or perhaps the oversman and also the manager, see that the miner does this. Where propping is done regularly, both the roof and tramways are the better for it, as the props

can be placed so as to keep the sleepers from shifting. Seams which have a hard roof may not require propping in the close places at all.

Mr SCHUMAN—If such an Act was passed, a large number of Government officials would require to be appointed to advise—almost superintend the work carried on in each colliery, and in the case of an accident, who would be responsible, as either party, perhaps both, would be to blame, and who would be the judge? while, at present, the onus rests mainly on the colliery master, also on his mining engineer, manager, oversman, &c.—officials of his own choosing and under his immediate control, all of them practically acquainted (or ought to be) with details of the *local* features, able to consult together on the spot on any emergency, and adopt immediate remedies—it is for him to look out to employ the best men, to see that they do their duty, and that security be established and maintained for those under his charge. You could hardly expect that much from a casual Government visitor, except he is placed there like an exciseman in a distillery.

Mr HOGG—That is just exactly what I meant. I want that judgment to be put into practice, and I do not think it is done sufficiently yet. After it is found out from experience what is the best method, let it be laid down as a rule. In many cases there is no rule, and props are left to be put up as it is deemed necessary.

Mr DUNDAS SIMPSON—You are speaking of stoop-and-room propping?

Mr HOGG—Any kind.

Mr SMART—Mr Hogg says a hard and fast line should be laid down. I may explain that in our main coal working, in a great portion of it, we have a solid rock roof, and we do not go many yards till it becomes a regular rotten roof for five fathoms up. Now, lay down a hard and fast line, and you would have the same propping in the solid as where the friable roof is.

The PRESIDENT—I think you misunderstand Mr Hogg. I think he said the manager should judge the place; and what he means, I presume, is that the manager should go round and see the place and state the distances at which the props are to be placed.

Mr MacCreath—I scarcely see how the putting up of props on the principle advocated would add any great expense to the working of the coal. They can be drawn and put up again, and it is only on the main drawing roads that actually they would be needed.

Mr Laird—My opinion is that there ought to be men appointed for propping wherever propping is required. My reason for that is: I remember now upwards of 20 years ago of going into a place where two men were working, and I suggested to them they would require a tree. They were two very practical men, and a capital safe roof it was, but they opened a "lype" on the side, and I happened to notice it. I brought it under their notice, and one of them said—"Yes, I will set up a tree as soon as I bore this hole." Before he bored the hole I went away, and I had just reached the pit-mouth when the word came that William M'Nair was killed. He was going to do it, but he never got it done.

Mr Faulds—Some of the members are expressing themselves as to a hard and fast line being laid down. I think in our district there is a pretty clear hard and fast line adopted already. As I have stated already, the colliers prop the whole place, and the fireman in going round and making his first inspection sees where a prop or a strap should be put, and makes a mark accordingly. On going his rounds a second time, if he finds the prop is not put up, he, the roadsman, oversman, or perhaps the manager should see that it is done. If it is not done, there is negligence or incompetency somewhere.

The President—I am afraid we can scarcely ask Mr Robson to close the discussion to-night. As to Mr Telfer's suggestion that we ascertain the practice elsewhere, I think that is a very admirable suggestion. What has been running in my mind is this:—The Scotch districts are pretty well known. There are ten districts in England. These may, again, be reduced to nine, because Durham and Northumberland are pretty much the same. I think in the course of ten or twelve days that these districts could be overtaken simply by two or three practical men being appointed with certain definite instructions which your Council would issue to them. If your funds will allow it, I think you should leave it to the judgment of the Council. (Applause).

Mr LAIRD—I can say a little about the practice in the North of England. I happened to work there about 30 years ago, both in Northumberland and Durham, and the first break I took out of my room there were two men who came in and set up props, just at the distances from where I was going to hole in the top coal. I said, "What is that?" and they were amused at me putting the question; but as regularly as I took out a break they put in props.

The PRESIDENT—What did you think of it?

Mr LAIRD—That it was a superabundance, to say the least of it.

The discussion was then adjourned, and as this was the last meeting this year, the President wished the members "a happy New-Year" when it came.

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Plate IX
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THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING, 13th JAN., 1881,

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON.

RALPH MOORE, Esq., President, in the Chair.

THE Secretary read the minutes of the last General meeting and Council meeting, which were approved of, and signed by the President.

The following gentlemen were then balloted for, and admitted as Ordinary Members:—

JOHN YOUNG, Coalmaster, Baljaffray Colliery, New Kilpatrick.
ALEXANDER CLELLAND, Colliery Manager, Bishopbriggs, Glasgow.
ALEXANDER RITCHIE, Overman, Clelland Colliery, Newarthill.

Other six gentlemen were then nominated as Ordinary Members, and will be balloted for at the first meeting.

MR ROBSONS' PAPER ON ACCIDENTS BY FALLS OF ROOF AND SIDES.

THE PRESIDENT, after wishing the members "A Happy New-Year," intimated that the first business was to wind up the discussion on Mr Robson's paper. One or two gentlemen have sent their remarks in writing, and these were read, but we might have had more. If there are no further remarks, I will ask Mr Robson to reply to the discussion.

Mr ROBSON—There are only one or two points requiring any further remarks from me. With regard to the mode of dealing

with seen danger, I think it would be found in practice that the fireman, or "competent person," would not be long detained in his rounds of inspection if it were required of him to *see a place made secure before leaving it*, at least not after the first or second time, because it would not take much time to support the roof exposed since his former visit, and a collier would very soon find out that there was nothing to be gained by his refusal to do at once what he knew he must do later.

As to the variable nature of the roofs being against systematic propping—the fact mentioned by one gentleman, that the roof changed from being very hard to very soft in a few yards, is, in my opinion, a very strong argument in favour of systematic propping, so as to ensure some means being taken to meet the changed condition when it came—probably before the workman was quite aware of it; and thus a place might be secure which, without such system, would likely be dangerous. Now, while it is quite true that the roofs are very variable, even within small areas, the various conditions under which they are met with are in general neither new nor uncommon. One seldom sees a roof or a working which is different from every one previously seen, nor do we come across any remarkable phenomenon hitherto unknown; and, when an accident happens at a particular place it can seldom be said that such an occurrence is the result of a new phase in mining, although it may be a change in the roof or seam at that place; on the contrary, by far the greater number of examples are merely repetitions of what, unfortunately, most of us have often seen. I do not, therefore, believe that this is at all a tenable objection against systematic propping.

With reference to the main point—the practicability of a system of propping and securing the roofs and sides as the workings advance, in every seam, or portion of a seam, a system could be laid down, based upon the peculiarities of roof, mode of working, &c., in conjunction with any casualties which may have occurred therein, or in other places similarly situated. Now, I think that it is clear such a system need not be "hard and fast," except to this extent—that when distances have been fixed by the manager, viz., that from the nearest supports to the face, and that between supports, those distances should not be made greater

at the caprice of any person under the manager; but that wherever the circumstances seemed to require it an increased number of props should be set up. There is really nothing in this method which could in any way tend to make the workmen and officials less careful in observing, as far as possible, the changes which occur, and increasing the means for safety where it is seen to be required; nor do I see anything which would hinder the manager from giving subsequent instructions to modify the system he laid down if, after a time, he saw fit to do so. I think the most of people will agree that the adoption of a maximum distance apart which props shall be placed will not make a place more unsafe; and further, that the setting up of props and other supports does prevent many an accident. Now, if this is so, and still so many happen, and bearing in mind the fact, which is sometimes overlooked, that by far the larger proportion of them occur in places where, and at times when, neither the miner working in the place, nor the person in charge of the district, expects them to occur, —surely, if such a system prevailed in every case, if we made up our minds to do in apparently safe places what is now done, or at least what is intended to be done, in places which are seen to be dangerous, we might reasonably hope that the result would be a diminution in the number of these accidents which all of us so much deplore.

While quite alive to the necessity for true economy in the working of mines generally, and to the cost of timber for the purposes of safety, I do not think with Mr Smart that there would be any danger of a colliery having to be abandoned on the ground of additional cost of pit-wood, created by the carrying out of what has been here considered. I rather think that ultimately, by the introduction of greater uniformity and method, there would be in this, as in other things, an actual saving wherever it was properly carried out.

I conclude by thanking those gentlemen who have enhanced the value of the paper by joining so freely in its discussion.

The PRESIDENT—I do not think I need say a word more, and, I am sure, you will give me permission to thank Mr Robson very cordially for the great trouble he has taken. I am certain the paper will have a very useful effect, and, I trust, will tend to

diminish the accidents from falls of roof and sides, which form such a large proportion in the lists of mining casualties. I am satisfied that the experience of you, gentlemen, will tell you that the additional props used within the last ten or fifteen years has had a great effect in the economy of propping. There is one remark I would like to make, viz., so far as I can find, no other Mining Institute has thought of introducing a paper on propping. It is very wonderful, for really propping forms a very important factor in the economy, not to talk of the safety, of a colliery, and, I believe, as people think of it, they will see more and more that there is a great deal to be made of thorough propping. For my part, I think nowhere is there more waste than in propping. If you go into some pits as I have done, and especially into the long-wall workings, and look back into the cundies, you see props, bent, wasted, doing no good, but a great deal of harm, while by a little method this would all be saved, very much to the benefit of the working. In some places, this is beginning to be very smartly looked after, and the wood drawn; and, I have no doubt, when you begin to think of it, you will find no little room for improvement in your present arrangements. I have much pleasure in moving a hearty vote of thanks to Mr Robson for his paper. (Applause.)

THE "TRANSACTIONS."

Mr DRINNAN called attention to the lateness of the period at which the "Transactions" are issued to the members, which did not allow time for the papers to be read before the next meeting.

The SECRETARY replied that everything was done which could be done to get the papers into the hands of the members as early as possible. After the shorthand writer's extended notes are received they have to be sent for correction to the different gentlemen who have taken part in the discussion of a paper, and, although most of them return the notes without undue delay, it sometimes happens that one gentlemen may keep them too long. This occurred the last time, when a gentleman kept them a week. The time between two meetings, however, is really too short to allow justice to be done to the "Transactions."

SCREENING, WITH A DESCRIPTION OF A PATENT APPARATUS.

By Mr JAMES S. DIXON.

The object of screening coal or any similar substance is to separate it into various descriptions, according to size, so as to suit the different uses to which it is to be put. It is believed that screening was originally instituted to meet the great competition which, with only slight intermissions, is the chronic state of the coal trade. All who are interested know the craving the public have for round coal, which I think is an acquired taste, because, in coals of a fine soft quality, the small is generally the best, and in many cases burns equally well or better than the round parts. It having become the custom to separate the produce as brought up the pit into two or more sizes, our object should now be to do so in the most perfect way possible. A legitimate adjunct of the screening process is that of removing pyrites, shale, and other foreign substances which, from whatever cause, are filled into the hutches along with the coal. The practice of screening and riddling underground has led to immense quantities of valuable fuel being lost to the nation by being burned in heaps at the pitmouth, or buried in the old wastes. Screens are usually formed of flat or tapered bars of iron or steel, which are kept at the required distance apart by washers strung on rods which pass through the bars, or by notches on cast-iron bearers. The screens are put up in a sloping position, very usually 1 perpendicular to 2 horizontal, so that the coals may slip down without undue violence. Where the produce has only to be separated into two qualities of coal and dross, one such screen is sufficient; but if various different sizes are required, this has to be done by others lying at a different slope being put under the first, so that whatever passes through the first may fall on the others, on each of which it is again divided into two sizes, or the screens may be in a continual slope, each having wider spaces between the bars than those above, so that, during the passage of the produce from top to bottom the pieces fall

through as they come to the spaces corresponding to their size. In such arrangements, each quality has to be conducted to the proper truck.

In Scotland, where the practice prevails of keeping the larger pieces for the purpose of heading the trucks, much space is necessary in railway sidings and screen scaffold, and also expense in having trimmers for each truck when a large output has to be handled. In other districts, where this practice does not prevail, 1000 tons a-day or more can be screened and run over a single pair of roads. In this case the screens stand abreast in a line, the distance between the centres being that from centre to centre of the trucks, a number of which are filled at the same time, and if no picking is necessary, very little labour suffices. For large outputs, especially of shipping coal, our plan appears to be a mistake, but here again we are the slaves of custom.

In regard to picking refuse from the coal during or after the the screening, this is generally accomplished by its passing from the screen on to a moving surface which carries it onwards towards the point of delivery into the truck. During its passage in this way the refuse is picked out by persons standing on a platform. Many ingenious methods of doing this are in operation. One patented by Mr Whitelaw, Motherwell (one of our members) consists of a moving table of iron plates fastened to chains. Another very excellent thing of a similar kind is made of flat hemp ropes fastened together. There are also in this district circular plates like the bottom of a very large pan mill for the same object. Another plan is to have a flat moveable plate in the length of the screen, after passing the latter the coals fall on this plate where they are picked, and on this being accomplished, the plate is tipped up, and the coals delivered into the truck.

The object is always to get as much round coal as possible, and therefore the saving of breakage during the screening process itself is a point which has not received the attention it deserves. The large lumps hurling down an ordinary screen smash themselves and make small pieces smaller still; they also smash themselves on the horizontal bars at the foot of the screen, or fall into the truck

with much more force than is necessary. The object I had in designing and constructing the screen I am about to describe was to obviate these drawbacks and to meet the requirements of screening as much as possible, viz.:—1st, to completely free the round coal passing into the truck from dross or gum; 2d, to pass the coal from the point at which it is delivered on to the screen to the truck as gently as possible, so as to save breakage; 3d, to enable the coal as it passes along on the screen to be picked, and bad pieces and foreign matter removed. As you will observe on the drawings (Plate XIII.), the screen consists of a web made of wire ropes, which are held together at the required distance apart by washers which are strung on iron rods $\frac{5}{8}$in. diameter. The ends of these rods are fastened to the single joints of a pitch chain, to the latter motion is imparted from a segmental drum, so that the whole web consisting of the ropes, washers, and washer rods, and pitch chain move horizontally—the motive power being a steam engine. There are four segmental drums to each screen, one of which is the driving drum, and the gearing between it and the steam engine should be of such ratio that with a sufficient rate of piston speed the screen may travel at about 40 to 45 feet per minute. As you will observe, the web passes down and travels in a trench underneath the railway on which the dross waggon stands. By this arrangement the screen can be made to pass over as many lines of rails as is desired. In the case of a coal with much admixture of refuse, the longer the screen and the slower its speed the better. The drums are 2ft. diameter and their cheeks are formed with polygonal facets to fit the pitch chain. The width of screen is comparatively immaterial; but in practice, 4ft. is found to work satisfactorily. There are horizontal grooves cut in the cleading of the drums to receive the washers where they project beyond the ropes; these also help to impart the motion of the driving drum to the screen. One of the two low drums is so constructed that its bearings can be moved up or down; by this the tightness of the web can be regulated. The pitch chain is made in the usual way of alternate double and single links of flat iron, the former being $2'' \times \frac{1}{2}''$, and the latter $2'' \times \frac{3}{4}''$, fastened together by $\frac{3}{4}''$ rivets. The ropes, $\frac{1}{2}''$ dia., are made of pliable wire and require either to be spliced or the ends fastened by a set of washers

made for this purpose. A necessary part of this arrangement of screen are the star wheels, of which there should be two sets—one set being between each alternate set of ropes. These star wheels are for the purpose of stirring up the coal where it lies thick on the screen, so as to allow all the small to pass through, this they do thoroughly. The star wheels are 12″ diameter, and are fastened to rods 1½″ square, and held at proper distances apart by hard wood washers; the ends of these rods where they project through the sides of screen are fitted with pinching pins which prevent the wheels revolving too easily. The star wheels are made to revolve by coming into contact with the washers. The framing consists of upright logs, 12 inches square, and the sides of screen and gangway for pickers, are made of 3 inch deals. At the delivery end, the coals should fall from the screen on to a swinging plate, and thus be passed gently into the truck. At Bent Colliery this screen is found to work satisfactorily, and to go a long way towards the object in view in designing it. Should it be wished to separate the produce of the pit into various sizes, the best way to do so with these screens will be to have a succession of them with the ropes at different distances apart, and the one delivering on to the next. In conclusion, the remarks on screening in general at the beginning of this paper, have been made with the object of opening a discussion on that important subject, which may usefully embrace a wider range than a mere criticism of my patent arrangement.

The PRESIDENT—This paper will be discussed at next meeting but still we would be very glad to hear some remarks upon it. The subject has not been so well attended to as it ought, but now, as people are becoming more fastidious as to the quality and size of coal, at least in Scotland, it has received more attention within the last five years than during the previous fifty. On the Continent, it has had a very great deal of attention, and I am told by some foreign gentlemen a great many expedients have been tried and with fair success, but if you gentlemen would direct your attention to the subject I have no doubt before next meeting we might have a good discussion on the paper. It is necessary to be as economical as possible, and in screening the coals it is necessary to break them as little as possible, and it is further necessary to

have the railways arranged to put as great a quantity as possible through one screen. I think these are the three great points. There is nothing, as far as regards the doing of it to my view, surpasses the plain riddle, but that is not an economical process. I see from the tenor of this paper that Mr Dixon is more anxious to get the best mode of screening than to advertise his new arrangement.

Mr DRINNAN—Do I understand Mr Dixon to say that a thousand tons had been screened over a single pair of rails?

Mr DIXON—Yes, I saw it done lately.

The PRESIDENT—Had they to clean the coals at all?

Mr DIXON—Very little. They do not trim their trucks at all the same as we do. They had, I think, about eight or ten screens. (Describes them on black board.) They had a couple of men at each screen, and a turntable at each. I think perhaps at that pit top they might have ten men, and they were putting over a thousand and twelve hundred tons a day.

Mr DRINNAN—Any of them I saw in England, the screens were all on one side.

Mr DIXON, in reply to the President, said the pitheadman regulated the filling of the waggons, and that the moving of them out and in was just the work of a minute or two.

Mr CLARK—That is the way they banked the coal in the east country, and it is always a loss of time.

Mr ROBSON—In my experienee, the practice was not to shift the whole range of waggons at once; but as soon as ever the first was full, it was shifted out and the next put into its place, and so on. There was almost no loss of time, the empty waggons feeding in as the loaded ones moved out; the banksmen being guided in emptying the tubs at the various screens in the line by the traps for holding and screening the coals which are worked by the screenmen.

The PRESIDENT—They have a back lye?

Mr DIXON—Yes.

The PRESIDENT—If they had the whole fifteen trucks to shift at the same time there would be a stoppage?

Mr DIXON—I saw them shift a train. They seemed to draw the sprags and the full waggons ran away while the empty ones ran in.

Mr GILCHRIST—I have seen a similar arrangement, and the whole thing was done in a minute. Fourteen trucks were run out, and fourteen empties run in to their place.

The PRESIDENT—Fourteen would not run out in one minute.

Mr GILCHRIST—Yes. They had raised nineteen hundred tons in ten hours, so there could not be very many minutes lost.

The PRESIDENT—There is one remark of Mr Dixon's worth noting, viz., so much time is spent in trimming the tops of the waggons. It seems to me lost labour.

Mr SMART—I do not see any difficulty as to the thousand tons the way he loads them. It is not one hundred tons for each screen. Why, we put 300 tons over a single screen.

Mr DRINNAN—We put between 700 and 800 tons over two screens.

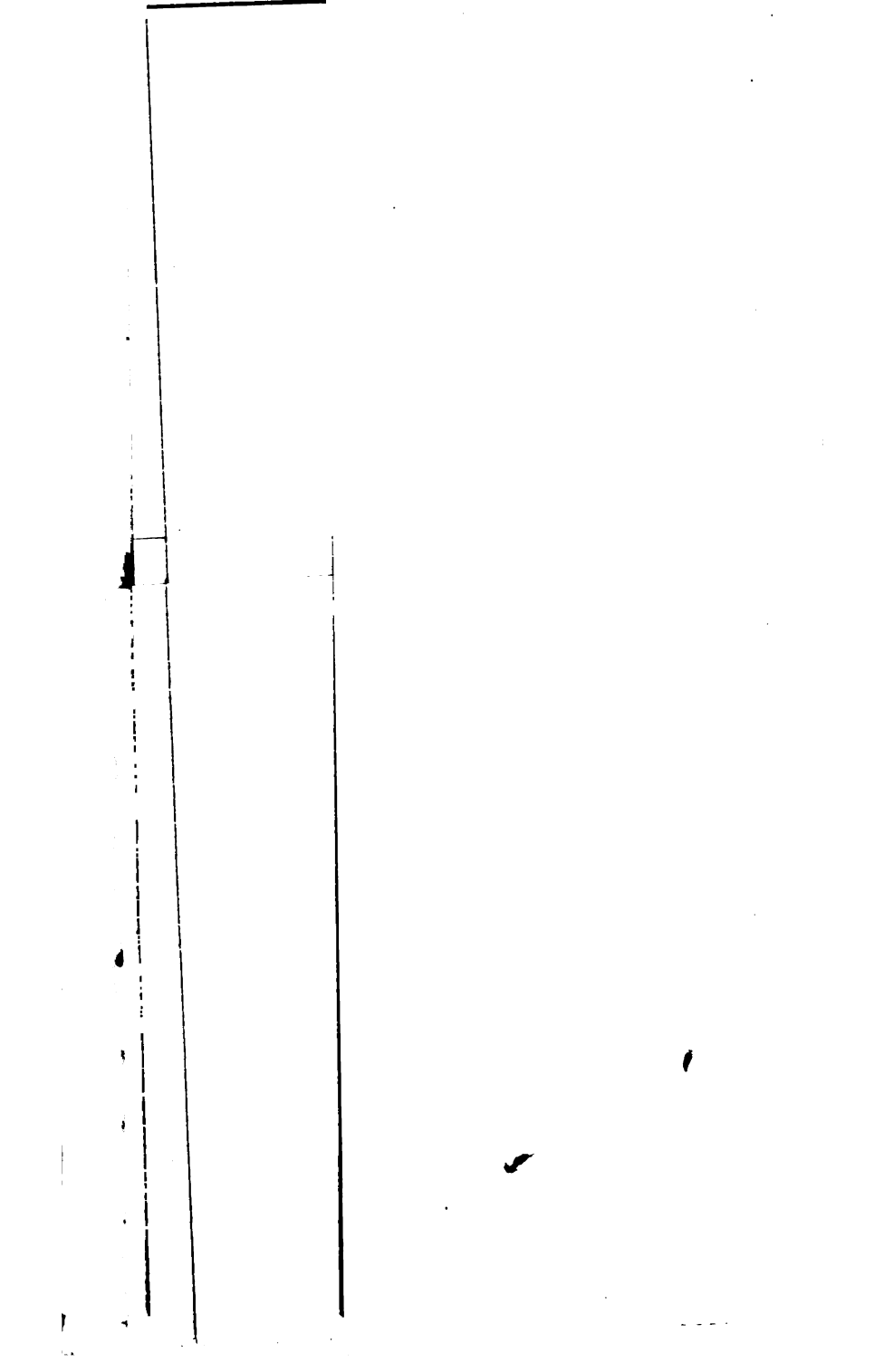
Mr DIXON—There is a limit to that. I know from experience you do not make such a good job.

Mr HASTIE—How much do you put over?

Mr DIXON—We put about 100 tons of round coal a-day over the patent screen.

The discussion was then adjourned.

[*The discussion on Mr Calderwood's paper will be published next month.*]



THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING, 13th JAN., 1881.

DISCUSSION OF MR CALDERWOOD'S PAPER ON "SOUTH STAFFORDSHIRE THICK COAL."

(Continued.)

The PRESIDENT—The next business is the discussion of Mr Robert Calderwood's paper on the "South Staffordshire Thick Coal." At last meeting, members were invited to write out any questions, and one gentleman (Mr Gardiner) has asked the following:—

1. Am I right in understanding "Fire Stink" to be a gas or gases which takes fire and ignites under certain conditions?
2. If so, can Mr Calderwood explain his own views, or those of others on these conditions, viz., (*a*) Is it a limited supply of air for a certain period, then a greatly increased supply that causes the fire? (*b*) Or a good supply all the time? (*c*) Or a bad supply all the time?
3. Are there many pyrites in the seams, what size, and state if left in waste?
4. Of what nature is the argillaceous shale left in the waste, *i.e.*, does it contain many pyrites, alum, sulphur, or any other substance to your knowledge that it assists, or is the sole cause of the so-called "Fire Stink" in the workings? (I do not ask a chemical analysis of the shale, but simply if Mr Calderwood is cognizant to the fact that it contains any of the compounds named; they will show themselves in a short period lying in the waste exposed to the atmosphere, or any atmosphere containing oxygen.)
5. State, if he can, the average amount of sulphur in coal or coals.
6. The market and nature of works supplied with the coal.

If there are no other questions, I shall ask Mr Calderwood to reply before the discussion of the paper proceeds.

Mr DIXON—I was just going to say to Mr Calderwood that

the diagrams refer to small sections of the workings, and to suggest, if he could make a sketch of the general plan of a part of the pit on the black board, he might give us a better idea.

Mr CALDERWOOD, in compliance with this suggestion, sketched a "panel," opening from the "boundary rib."

Mr MACCREATH—I would like to ask if there is not less gas in the waste of the sulphur or new mine coal than in the thick coal?

Mr CALDERWOOD—They are much about the same. There is no spontaneous combustion in it.

Mr GARDINER.—I have made a few notes from Mr Calderwood's paper, and, with your permission, I will read them. It is a drawback on the value of his paper not to have a sketch map of the district attached, to exhibit the area of this wonderful field, when he has described its extent so minutely. From the minute description of the various modes of working, I have no doubt the object was and is, get as much coal as possible, and really not one system previously thought on, fully carried out, but simply do this as this would do with you, to meet the emergency of the minute. These few passing remarks on the two first sections of the paper, bring me to one I mean to dwell on—"Fire Stink or Breeding Fire" Section. For convenience sake, I have numbered the paragraphs of section (1), (2), (3), &c., to (7). Commencing on page 176, paragraph 1, after giving a few, very few indeed, causes, he draws his conclusion as follows:—"They are due to a purely mechanical, assisted by chemical action." I suppose he means "generation" instead of "distillation," as we talk of generating a gas and distilling a liquid. No doubt, heat is generated by friction, but friction to generate heat, on the point under notice, is open to be questioned. The cause which is stated in the next clause is proof to me, at least, that pressure comes so slowly that the heat generated by it would have no effect. I quite agree with those who say it is "Spontaneous Combustion." From my own knowledge, this sponstaneous combustion is brought about as follows: When the waste is partially filled with shale and *debris* from the coal working, which has many pyrites in it, and be it small or be it large, if it is a short time exposed to the air current, or damp

when closed, will be sure to heat by the decomposition of the iron pyrites. The great affinity which the sulphur has for the oxygen of the water and air generates heat rapidly. Paragraph 2, the carbonic acid is the natural outcome of coal and shale, and is in no way due to the decomposing influence in the waste. I quite agree with Mr Calderwood on the "only remedy," plenty of air. Wastes containing stowage of this nature, should be provided with air-ways, or water-ways. In cases of the waste or "gob" being in the centre of workings, provisions for either air or water should on no consideration be omitted. I had on three different occasions to cut out heated waste, where the temperature was over 200° Fah. The indication I had on the first occasion was steam coming out of stowage ; on cutting into the seat of the trouble or point of the highest temperature, I found open space between roof and top of stowage. Paragraph 3, I cannot understand what is meant by "when the combustion has gone so far as to give off sulphuretted hydrogen," for when combustion has just commenced sulphuretted hydrogen is envolved, and goes on very rapidly if hydrogen is to be had at all. Paragraph 4, plenty air on all occasions, I consider the antidote for "Fire Stink." Paragraph 5, "Gob" fire, I am of the opinion, is caused by decomposition of iron pyrites, and it is no criterion whether or not the coal contains sulphur disseminated through it, for a coal containing iron pyrites to any great extent invariably has little sulphur disseminated through it chemically.

Mr CALDERWOOD, at the request of the President and others, described the system of working with the aid of the black board.

The PRESIDENT, addressing Mr Anderson, said the system resembled very much that by which Messrs Merry & Cuninghame were working the pyotshaw and main coal near Wishaw.

Mr ANDERSON—Yes, so far as it goes, but we work the under and then the upper coal.

Mr DIXON—In this case they work the upper first.

The PRESIDENT—What is the depression? Have you a land weight so to speak? Does it go down on the surface.

Mr CALDERWOOD—That depends altogether on the way you work it. It does not go down so much as in the case of the Dudley rib and pillar workings, for this reason: when the clays

between the rock and shales get the water they swell so much that you scarcely notice the depression except at the break of the rib.

Mr HASTIE—How much surface is on the top of the coal at that particular point.

Mr CALDERWOOD—150 to 250 yards.

In reply to Mr Clark, Mr CALDERWOOD said they had got very little water, but where it existed they were obliged to pump or syphon it. The workings were not steep, the steepest being 1 in 5, and the usual 1 in 10 to 1 in 20, though sometimes perfectly level.

Mr DIXON—Has the plan ever been tried of working with a portion long-wall, and then following up with the next portion and the next, and so on, going in instead of coming out?

Mr CALDERWOOD—No, there would be nothing to build with, but it has been tried to work it in two sections—taking the first in the middle of the coal, in the usual way—but they found it not to do, for this reason: in the top portion they got most fire-stink. The Veins (salt bat) is a soft carbonaceous shale, very oily; the bat, under the "Veins," is much the same, and it is here where most of the fire occurs. The only party I know who tried it started and drove his roads in the Heath coal bat, expecting to take it in equal divisions, but he was obliged to shut it up.

Mr DIXON—Why?

Mr CALDERWOOD—Because of fire, and three years this month they had a run in from the top coal of live fire while working the under, and a man was buried in it whose body has not been got out yet.

The PRESIDENT said the system being explained looked unwieldy.

Mr CALDERWOOD—You would be surprised if you saw it worked.

The PRESIDENT—About three weeks ago, I saw Mr Anderson take out stoops very much like that, and it was a remarkably neat working considering all things.

Mr CLARK asked how they got to the bottom after going to the boundary?

Mr CALDERWOOD answered that they had headings in the top

and also in the bottom, both beginning at the shaft. After the first working, the place stands for three years, if they can wait so long, and then they begin to the second. In working the bottom coal (second working), the first operation is to drive a set of three gait-roads, 25 yards between each road, and when these reach the boundary a face about 75 yards wide is opened out and worked back. While this is going on, another set of gait-roads are being driven, leaving 100 yards of solid coal between each set, and when these reach the boundary, the same width of coal (75 yards) is also worked back. Thus, there are 75 yards of coal worked, and 75 yards left, which is followed by another panel of 75 yards, and so on. The portions of coal left between the gobs are afterwards got by driving gait-roads, and working back in the same manner. They are left in until the waste or gob on each side is all settled, and there is no possibility of getting "stink" from it. That is the only difficulty. That is not the usual way of doing it, but it is the way I have adopted since I have gone there. It is a long-wall in coming back. I would not call it stoop-and-room. In the top coal, I generally leave pillars of 33 yards; I have left as high as 50 yards. We do not leave them square but oblong.

Mr DIXON—The difference is, there are no buildings in behind. That is a difference, and that is a point I brought out in a previous discussion, viz., whether buildings could not be put up to keep the weight off stoops when removing them.

Mr CALDERWOOD—I think it would be advantageous if you could.

Mr DIXON—The conclusion come to in the previous discussion was that it would send the weight over on the stoop, and do more harm than good.

Mr HASTIE—The simpler way,—not to get the weight,—is to have bigger stoops.

The PRESIDENT—Your system resolves itself simply into working with a large stoop, and in taking out the stoops, instead of carrying the strata upon props, you keep up buildings behind, —that is the difference?

Mr CALDERWOOD—Exactly.

In reply to the Secretary, Mr CALDERWOOD said the buildings were not taken out until the whole of the bottom was out.

Mr GILCHRIST—Well, they are of no use.

Mr CALDERWOOD—It is of use as a building until we get this off. It is only a small portion of the top that is left..

Mr GILCHRIST—If you "hole" the top of the building the roof comes down, and the building supports nothing.

Mr CALDERWOOD—We sometimes have building here (showing).

Mr GILCHRIST—But still they are always holed out in the top.

Mr CALDERWOOD—Yes.

The PRESIDENT—That (pointing) supports nothing.

Mr CALDERWOOD—Yes, you are right so far. It only serves until other buildings are sufficiently advanced to admit of that building being drawn.

Mr GILCHRIST—Then in the way Mr Dixon was speaking of putting buildings in to support the roof of our stoop-and-room workings, they would always be left standing,—you could not take them out.

Mr DIXON—Yes, that is the difficulty.

The PRESIDENT—Well, let us call things by their right names. Are we at one that it is but a stoop-and-room working?

Mr MACCREATH—It is about it, but it is of little consequence if the coal is got out.

The PRESIDENT—There is this difference, you never get the full weight. You never get the long-wall weight.

Mr ROBSON—I do not think that Mr Calderwood in his paper calls it long-wall. He simply says the "holing' is done long-wall fashion and explains the driving in of the gait-roads in the solid and then opening out a face at the boundary and the putting in of buildings or "cogs" in the "gob" left in the back coming.

The PRESIDENT—That is all right if we have it so, but the impression on my mind was that it was described as a long-wall working which it is not, because a long-wall working is that in which you get the extreme weight over a large space. In this you don't get the land weight, for you are supported on both sides.

Mr DRINNAN—Would Mr Calderwood explain what width he drives the road when working the lower portion?

Mr CALDERWOOD—Six feet, and five feet six inches high.

Mr MACCREATH—Is that mode of working called "long-wall working" in that district?

Mr CALDERWOOD—It is called "long work" to distinguish it from "rib and pillar."

Mr DIXON—Have you ever taken out any of those 100-yard pillars you leave?

Mr CALDERWOOD—Oh, yes.

Mr DIXON—Because you would find more weight on the pillars than before, for they act as an abutment does to a bridge. The whole weight is thrown on the abutment, and these are merely abutments on each side.

Mr CALDERWOOD—We have a soft bottom. It creeps in a good bit, and that saves a good deal of the weight. If we had a hard bottom, I have no doubt it would crush it.

Mr HASTIE—Do the miners in taking out the centre pillar not find it harder to work?

Mr CALDERWOOD—Not at all. They may find it a little worse to work when it gets to cross roads.

Mr HASTIE—That shows there is an extra weight.

Mr CALDERWOOD—It may be at the cross roads.

Mr HASTIE—Do you not find more loss of coal in that mode of working?

Mr CALDERWOOD—Not so much as in the "rib and pillar."

Mr HASTIE—There is a loss?

Mr CALDERWOOD—Oh, yes; there is a loss of coal. We get a little over eleven hundred tons to the acre per foot thick. The coal is of light specific gravity.

Mr MACCREATH—Are the tons 20 cwt?

Mr CALDERWOOD—Yes. I do not think we lose more than 10 per cent.

Mr HASTIE—Taking the whole field, how much per cent. is got out with that system?

Mr CALDERWOOD—Ninety per cent. in long-work, if it is well looked after. Of course, if not looked after and if they find a piece difficult to get they run the gob on the top of it and hide it.

Mr DRINNAN—I am afraid Mr Calderwood will find us somewhat troublesome, but the fact is we have had little time to look into the paper. I would, however, like to ask another question: as to the position of your gait roads when you are taking forward that 25 feet?

Mr CALDERWOOD—We are not taking forward, we are taking it back. Our gait roads are behind. We drive to the march and come back.

Mr DRINNAN—I misunderstood your reply to a gentleman. I understood you to come back to the shaft and go out again.

Mr CALDERWOOD—We go back to the shaft and drive in gait roads.

The PRESIDENT—It is stoop-and-room, with large pillars and narrow openings.

Mr CALDERWOOD—Very narrow, only six feet wide to make them stand. Sometimes the roof of these roads break, especially if a piece of top coal be over it.

A MEMBER—Is Mr Calderwood including the top portion of the coal in the ten per cent. lost?

Mr CALDERWOOD—In general we lose none of that at all Sometimes we lose a little for want of stuff to build cogs, and sometimes use slack and coal to do that.

Mr CLARK asked if it would not do to have the gait-ways only in the bottom coal?

Mr CALDERWOOD—You would thereby lose the topmost and best portion of the coal. It is always buried by the gob. We do lose a bit of the top part of the bottom coal sometimes—a foot or 18 inches.

The PRESIDENT—Suppose that the upper portion of this second working were equally valuable with the top portion of the seam, which you make a separate working, would you also make this a separate working—making three workings instead of two?

Mr CALDERWOOD—No, we don't lose so much of it, but if we had all this to come back and leave with it, we would lose it all. That is the experience of those who have worked it. I have never worked it.

Mr CLARK—Did you drive your top and bottom coal gait-ways at the same time.

Mr CALDERWOOD—No, we drive the top coal roads first, work that off, and drive the bottom coal roads afterwards.

Mr CLARK—Do you work the top coal first?

Mr CALDERWOOD—Yes. The upper seam is worked first, and then it stands three years before the second is commenced.

Mr GARDINER asked if it would not be better, after letting the top coal stand for three years, to work it long-wall—if this had been tried?

Mr CALDERWOOD—You might work the Slipper coal long-wall if you could find stuff to build with, but in case of fire you could not shut it off. I have tried to work the top coal long-wall, but I could not keep roads—I could not keep a road-way for it creeping.

Mr GARDINER—I wrought a place where there was a division in the coal which was 15ft. thick, wrought the bottom portion, left it to settle down. It came down about 2ft., then we went back and wrought the upper portion just like commencing to work anew. We could have wrought on very well that way, only we found, after we went in a bit, our stowage was short, and there was a difficulty of getting stowage to hold up the roof.

Mr CALDERWOOD—You have such a weight upon here (pointing) this will come down with it.

Mr FAULDS—Suppose you work the upper seam the same as you do now, how would it do to work the other the same as in long-wall?

Mr CALDERWOOD—You would have it on fire.

Mr SMART—I see one great difficulty in this field is the fire stink. It is a thing which is interesting us very much at present, and I think, as far as I understood Mr Calderwood, he said that they did not begin the 100 yards panel until once the one wrought out was thoroughly still so that no fire stink was brought out.

Mr CALDERWOOD—To prevent the possibility of it coming out.

Mr SMART—Our experience is the longer you leave a waste standing subject to spontaneous combustion, the more likely it is to generate.

Mr CALDERWOOD—It is more apt to generate that way, but we like to have it as cool as possible. What I mean is, we want to bring that back as quickly as possible.

Mr SMART—You say the only remedy is proper ventilation.

Mr CALDERWOOD—I do not say that. I say I think the best remedy is quick working and good ventilation.

Mr SMART—A bank of dross 10ft. high has been known with us to generate spontaneous combustion. Mr Gardiner has referred

to the East Indies, and he has given his experience that the mines there were very much subject to spontaneous combustion. You do not think that is particularly due to the high temperature of the climate of the East Indies. We know if we ship a cargo of coal here to go out to the East Indies they are perfectly hot when discharged. I have heard it expressed over and over again by captains of vessels that they could scarcely handle the coal, and I think that is one thing that may cause spontaneous combustion in our coals going there. But Mr Calderwood thinks after that it remains for three years on fire.

Mr CALDERWOOD—When there is a great fire you never know how long it would be. If you find it beginning to get warm in course of working, you can leave a slight rib of perhaps 6ft. to take the air off it.

The PRESIDENT—I understand you adopt that particular system as being the best for dealing with spontaneous combustion.

Mr CALDERWOOD—Exactly, and we think it best for the coal as well.

Mr HASTIE—In that particular system what is the longest road from the pit bottom to the boundary?

Mr CALDERWOOD—The roads are sometimes driven a mile or two before coal is got, except what the roads produce themselves.

Mr HASTIE—That is a grievance here—they are wanting money.

Mr GARDINER—I may say in reply to Mr Smart the temperature in the Worora mines is 84°.

Mr CALDERWOOD—The temperature with us is only a little over 60°. At the request of the President, Mr Calderwood described, with the aid of the black board, the "rib and pillar" system of working.

The PRESIDENT—How much more coal do you get by your system than by that system?

Mr CALDERWOOD—I could scarcely say. I have only seen it worked. It is dearer, and it produces more dross from the quantity of shearing they have got. They have no buildings. The dross is half and half in bottom coal, while it is 30 per cent. in ours, but you must remember our dross is not like the dross in Lanarkshire. Ours is almost from the size of your fist down.

We sometimes screen it through an inch and a half screen, and from that we can take 50 per cent. of clean coal. What you call your dross we sell as "duff." I may say we load with a rake and basket, a very handy way where you have no bottom to load off.

The PRESIDENT—We have criticised Mr Calderwood's paper very well; have you any more questions?

Mr D. SIMPSON—There is one more I would like to ask. Mr Calderwood says he starts from the pit bottom and drives in the top coal to the end of his boundary, and after working that back allows it to remain quiet for three years. You go back and commence at the pit bottom again; well, do you start from the pit bottom and run the roads to the same bearing as the roads were on above?

Mr CALDERWOOD—Yes.

Mr SIMPSON—But in the bottom section of the coal you cut through again to the old waste?

Mr CALDERWOOD—Yes.

The PRESIDENT—You leave, as I understand, large blocks?

Mr CALDERWOOD—Well, the way you put it, you put it as stoop-and-room. I don't. As I put it, it is long-wall or a long working.

Mr GARDINER mentioned that the Coltness Iron Co. followed the same plan at Wilsontown.

Mr DRINNAN—Mr Calderwood said he found it incompetent to work the upper portion long-wall; would he state the obstacles?

Mr CALDERWOOD—The bad roof and the soft bottom. We could not keep roads in it at all, and it was very dangerous. In fact, we had to carry them on timber, and that cost money.

The PRESIDENT—Had you many accidents in that bad roof?

Mr CALDERWOOD—We did not carry it on very long. I have never had any but one serious accident.

Mr SMART—You say you have a bad bottom?

Mr CALDERWOOD—The coal crushes down through the Heath coal bat, which is soft.

Mr SMART—You mean the bottom of the seam altogether?

Mr CALDERWOOD—No. That is the Gubbin measures—little ironstone balls and soft shale.

The PRESIDENT—I think we have now exhausted the mode of working; perhaps Mr Calderwood will next direct his attention to the questions and remarks of Mr Gardiner.

Mr GARDINER—I think the questions have nearly all been answered in the discussion unless the last one, which is not material to the discussion.

Mr CALDERWOOD—That is about the pyrites? We have no pyrites, none whatever. It is due to salts in the coal and chemical action on these salts. In burning, the mineral gives off the fumes of various salts, and the water is all as salt as brine, and about as thick.

Mr GARDINER—Is there any sulphur in the coal?

Mr CALDERWOOD—Two per cent.

Mr GARDINER—And in the shale?

Mr CALDERWOOD—Little or nothing in the shale. I have some samples here which you can see.

Mr GARDINER—Do you know what sort of salts they are?

Mr CALDERWOOD—Chiefly potassium and chloride of sodium.

The PRESIDENT—If there are no other questions, I think we may close the discussion on this paper. There is one remark struck me in regard to what has been stated by Mr Smart. I think if he would keep the dross bing not more than 5 feet high, he would not have spontaneous combustion. I recollect being in a pit in Fife not long since, and they find there that whenever the dross exceeds 5 feet high in the workings, they have a tendency to spontaneous combustion, but if they kept it 5 feet with good air, it did not take fire so readily. In closing the discussion, I have to state that Mr Calderwood has given us a very valuable paper, and the questions put to him have made it, I daresay, still more so. It is a different system from what we have been accustomed to. I believe most of us think that if it were a real long-wall working, we would find it better to work the lower portion first, because, if the upper is worked first, the weight on the face breaks the lower. Mr Calderwood, of course, from various causes prefers it so, but he would find, if he were working at a depth of five hundred yards instead of one hundred, this lower portion would be much crushed. I think the least

thing we can do is to move a hearty vote of thanks to Mr Calderwood for the trouble he has taken in writing the paper, and in coming to explain it. (Applause.)

Since the above discussion took place, Mr Calderwood has furnished plans shewing the "Rib and Pillar" and "Panel" modes of working the Staffordshire Thick Coal, which are given on Plate XIV.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING, 10th FEB., 1881,

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON.

RALPH MOORE, Esq., President, in the Chair.

THE SECRETARY read the minutes of the last General Meeting and Council Meeting, which were approved of, and signed by the President.

The following gentlemen were balloted for, and admitted as Ordinary Members :—

JOHN HENDRIE, Coalmaster, Maryville Colliery, Uddingston.

JOHN B. DALZELL, Coalmaster, Hill Colliery, Dalserf.

JONATHAN HYSLOP, General Manager, Kinneil Iron Works, Bo'ness.

JOHN M'NAB, Managing Director, Flemington Colliery, Cambuslang.

ARCHIBALD KERR, Mining Student, Hamilton.

DAVID BRYDEN, Colliery Manager, Coylton, Ayr.

Other six gentlemen were then nominated as Ordinary Members, and will be balloted for at the first meeting.

DISCUSSION ON MR JAMES S. DIXON'S PAPER ON "SCREENING COAL."

The PRESIDENT—We begin with the discussion of Mr Dixon's paper on "Screening Coal."

Mr SIMPSON—I think this is a very important subject which has been brought before the Institute, but I am not quite sure if Mr Dixon has treated it in his usual exhaustive manner. I think he might have said a great deal more. It seems to me there are three points hurtful to the coal. First of all, when they are tipped out of the tub on to the screen; then at the bottom of the screen when they are dropped into the waggon; and during the course of transit to the market. I am not quite sure whether the most damage is not done to the coal during the transit to the market. When you consider the shunting that a waggon receives, it is not to be wondered that at the end of the journey a good many of the corners are taken off and reduced into small coals. But as regards the screening itself, it seems to me the ordinary screen is perhaps as good an arrangement as could possibly be got to do the work. Of course, the ordinary screen can be misused. In tipping the hutches, the coal may be thrown over so as to let it have very little screening, and no doubt a great deal of dross go with the coal, but I think if care is taken, and the tipping of the hutches carefully and slowly done, the dross can be taken as thoroughly out of the coal by the present mode of screening as by any other. Of course this means that the output or quantity put over the screen will not be so great; but when you consider that Mr Dixon with his patent screen is only able to put over a hundred tons of round coal a-day, I think if any one only puts the same quantity over our present screens he will be able to screen it well and take the dross out of it. Mr Dixon's patent screen appears to me only to be better than the common screen because it is so arranged that the coal can be cleaned, and I think this is a great thing to be aimed at. The cleaning of the coal is a subject deserving of our best consideration, and a great deal more attention should be paid to it than has been the case. I do not think there is a seam of coal but requires cleaning, even our cleanest; and there are seams in this

district going into the market which I am satisfied do not contain less than 3 per cent. of impurities. Even pretty clean-looking seams will be found to contain 2 per cent. Now, supposing the output of a pit to be 500 tons a-day, and 2 per cent. of it is composed of brasses and stones, that is 10 tons a-day of bad material. Upon that 10 tons a-day I suppose that we may take it that on an average there will be 2s a ton of dues paid. There may also be 9d a ton paid for lordship. That is 20s to the railway company and 7s 6d to the landlord daily, the effect of which is to lower the value of your coal in the market to the extent of perhaps 3d to 6d a ton. Now, that is a very serious matter, and the question becomes, should we not rather expend this money in employing means to clean the coal. The 27s 6d spent on labour—if it is judiciously employed—I am satisfied will take the impurities out of the coal. There is another matter in connection with these impurities. We are all aware of the number of vessels that have been lost by spontaneous combustion in the coal. Now, I think if we could take these brasses out, it would have the effect certainly of reducing the danger in that respect. I see there is a point mentioned by you, sir, with regard to the topping of waggons. With all due deference, I think you are wrong as regards that, especially at the present time. If waggons could be trimmed so as to carry half-a-ton more than at present, that comes to about 10 per cent. in the waggons. Now, I think if the railway companies had 10 per cent. more waggons at the present time, we would be much better off than we are.

Mr JOHN MORISON—In England, there is something similar to what we find here—just sloping screens, passing a great quantity over in a very short time—I should say a hundred tons a screen in eleven hours. An objection I could see to Mr Dixon's screen would be its breaking the small coals smaller by the motion of the rods—one rod perhaps travelling a little faster than the other. Not exactly faster, but with jerks nipping the coal as it comes through.

Mr DIXON—The ropes are fixed; they all travel at the same rate.

Mr MORISON—But is it not possible that there would be a jerk on one rope and not on another? As the rods are running, larger coal would lie on them than could go through, and any

strain on the rods would nip the coals and make them smaller. A rope tight strung with very little touch would vibrate.

Mr DIXON—I do not find that. As regards what Mr Morison has said, I do not think there is any use prolonging the discussion. The ropes do not move separately. What he suggests does not take place—the screen moves as a whole, and no rope can move independent of the others.

Mr MORISON—Can this screen be used with tubs without end doors?

Mr DIXON—It might. We have tried the screen by tipping the hutches as quickly as possible, putting on 15 or 16 cwt. of coal at once, and it did perfectly well.

The PRESIDENT—As you will have observed in Lanarkshire, one screen very often screens 300 tons a-day, one waggon being filled at a time and then shifted. So far as I have observed the English system—indeed, it has been introduced here at Earnock as an improvement—there are a number of screens with a waggon at each, all being filled at the same time, and, of course, if you have a dozen of screens instead of one, the coals go more slowly over each, and more time is given to clean them. The great object, I think, both of Mr Dixon, here, and of Mr Simpson, has been to get some arrangement whereby the coals can be slowly cleaned from the rubbish. For that purpose, this horizontal plate screen has been tried; another arrangement is a circular table; a third, or rather the first in order of invention, is a sort of Venetian-plated moving platform about 15 to 20 and 25 feet long, upon which the coals land, after being passed over one screen, and are taken along, while boys on each side clean them. Which is the best, I think, will be what the members will consider worth discussing—whether the horizontal table, or the circular table, or some mode by which the coals pass slowly along so that the boys may pick off the stones, or a screen where the boys are placed, as in England, at the end of the screen cleaning the coal leisurely.

Mr MORISON—I have seen screens made of hemp in one instance, of sheet-iron in another, travelling in that way perhaps a distance of 30 yards along, but that is only in coking collieries where it is necessary to pick out every bit of dirt. In other

collieries I never saw anything except the ordinary sloping screens. There are generally two old men at the plate at the bottom of the screen. These screen something like 800 tons a-day per 9 screens.

Mr DIXON—I wrote to the north of England where I had seen those screens, and this is a note of the reply:—Output of pit, 700 tons in 11 hours; number of screens, 6; number of men shoving tubs, 5; at screens, 12—in all, 17. The screens are 10½ feet centre to centre, and two lines of rails only are provided, one for dross and one for coal; the time occupied in changing is about two minutes.

Mr SIMPSON—It is the same system as is practised about Whitehaven, where they have men and women at the bottom of the screens for picking.

Mr ROBSON—In general cases, in addition to the two men on each screen, they have boys at each waggon, who stand on a small platform at the edge of the waggon, ready to jump down as the waggon is being filled, and pick out any impurities which escape the men at the foot of the screen. There is generally one boy on each waggon, so that in the case referred to by Mr Dixon, independent of the five banksmen and twelve screenmen, there would be six boys, or twenty-three persons in all.

The PRESIDENT—Are you reduced to this—that you have 300 tons to 100,—100 tons being the practice in the North of England? That brings you to the point as to whether the mechanical arrangement here on one screen or numerous screens is best.

Mr SIMPSON—I have not the least doubt, Mr President, that if the coal is to be thoroughly picked the English arrangement is the best. Although I have another arrangement myself in operation, I think the English mode the most thorough. You cannot put a great quantity of coals through your hands and clean them thoroughly.

The PRESIDENT—In Lanarkshire, where few screens are employed, there is the expense of a man shifting the waggons. That is an extra thing. Where there are many screens employed the range of waggons is removed at once.

Mr DIXON—I have none. What I admire in this system is not

so much the quantity, but the fact that two small lines of railways and simple scaffolding is needed, whereby the complicated scaffolding, such as at Earnock, is avoided. The waggons run out themselves.

Mr SIMPSON—One man is required for shifting waggons for 250 tons.

The PRESIDENT—That would be equal to 2½ in the 600 tons Mr Dixon is speaking of.

Mr GILCHRIST—Reference has been made to the arrangement at Earnock. It is something similar to the English arrangement with this difference: so far as I noticed in England the waggons are all one size, so they build the screens from centre to centre exactly the length of the waggon. With the different sizes of waggons we have here we had to make provision for the longest. So that our screens are 20 feet from centre to centre. We have three different kinds of coal, each requiring a waggon and on a different line of rails, filling at the same time. One man shifts the coal waggons and another the dross waggons, so we have two men shifting for the three screens. We have nine waggons at three screens,—three for coal, three for nutts, and three for dross. We pass on an average 270 tons per day of clean coal into the waggons at these screens; taking the dross at 33 per cent. there will be 406 tons per day, or about 135 tons per screen. As to the mode of screening, we considered very carefully what would be the best manner of screening and cleaning coal, and we thought machinery was objectionable. We had, in view of a large output, to erect a large scaffold, but it is in no way complicated. All the screens are separate, so we can stop any screen at any time to suit the output.

Mr GARDINER—In India, the screens were a sort of modification of the system in Scotland, where the screens have on an average a slope of one in two. The way we used to do, we had a slope of one in four and six, and had two men on planks—one on either side—with rakes to pick out all the stones. Being so flat they had to push or draw the coal along. The object was to give time to pick out the stones. When you attended to the men and kept them at their work, it was satisfactory, but if you did not watch them they pushed it on, and it was not screened at all. I

think the incline was better for the coal. In this district, it seems to me, you would require a different angle for the ell and splint coals.

The PRESIDENT—If you would just take a comparison betwixt Mr Dixon's screen and an ordinary inclined screen.

Mr GARDINER—I would have liked to ask a question as to the particular expense per ton. Mr Dixon says he passes about one hundred tons over; at what expense per ton would that be?

Mr DIXON—About 1d per ton for picking.

The PRESIDENT—Yes; it is not the picking exactly, but the facilities for picking. If you picked them as well in a common screen, it would cost as much?

Mr DIXON—I think it would. That is to say, in any other arrangement.

The PRESIDENT—Then, perhaps gentlemen would direct their attention to the point, what is the best mode of cleaning coals at a reasonable cost? The question appears to resolve itself into machinery or no machinery, granted you can clean the coals as well the one way as the other if you take time to it.

Mr MORISON—How would this system do, supposing there are two different kinds of coal that you wanted to go into two different roads?

Mr DIXON—You would require separate screens for each kind of coal.

Mr MORISON—It would affect the question of the size of the heapstead, because the small of one coal should not mix with the small coal of another. In same cases, you must have them going into different waggons and roads; therefore, your screens could not be alongside.

Mr DIXON—No, you would require to make one screen behind and another in front. It is a matter of arrangement.

Mr TELFER—I may say we had an ordinary folding plate together with the system of turntable screens, and I really think we can screen and clean a larger output with the turntable than with the other. We can with it put out 250 tons easily, and with the ordinary plate we could not do that.

Mr SIMPSON—Is that what Mr Dixon styles "the pan mill?"

Mr TELFER—Yes. I think the turntable is worth all the

expense of the table and engine as well, as compared with the ordinary plate; and, as to the shifting of the waggons at screens, at one of our pits with an output of over 400 tons, under ordinary circumstances, and with a proper gradient on the waggon way, one man shifts the waggons easily.

Mr SIMPSON—I believe that is so. When I gave 250 tons, I meant two men was the number we have just now for 500 tons, but if we were only putting out 400 tons we would do with one man, but where you exceed that you require more.

Mr BAIRD—I am impressed with the idea that mechanical cleaning is by far the best, because you can regulate the speed to your wants. If the coal is very dirty, you may take as much time as you like. Undoubtedly it is the best.

Mr BISHOP—At Cadzow, we work with ordinary screens. We have not so much dirt in our coal as requires special picking, and by taking time, with the ordinary screens, get the dross perfectly out. We have a hinged plate at the foot of scree to run the coal into the waggons. Stones might be taken out there, but we do not require it. We put over 250 to 300 tons gross per screen, screening the coal properly—that is, just cleaning it from dross. If you put a greater quantity over it is hurried too much.

The PRESIDENT—It is scarcely worth while carrying the discussion forward to another meeting. We have present all the gentlemen who have tried mechanical screening—as we may term it—with the exception of Mr Whitelaw. If we take the opinion of Mr Simpson, he admits his is not the best arrangement, and that the English arrangement—which is non-mechanical—is the best. However, I am rather inclined myself to take the view of Mr Telfer, that in the end mechanical screening will come to be the best. We have not yet had a great deal of experience of the mechanical arrangement, but what we have had is rather favourable, and we have the Messrs Baird, who are not slow to adopt any good thing, adopting it. I can see a good deal of force in what Mr Bishop says: if you only want to clean the dross out of the coal, I cannot see the slightest occasion for any mechanical arrangement. While, therefore, so far as I can judge of the discussion, we would like a little more time and experience before we can decide between mechanical and non-mechanical arrange-

ments. It has been well brought out that the former have not failed, and are worthy of more attention than they have yet got. It would be well if Mr Dixon would give a plan of the ordinary Scotch arrangement with one screen and the back lyes, and, if he had the materials, a pithead arrangement showing the English mode of screening, so that a comparison could be made with the English arrangement. So far as I can see, the Scotch practice is not adopted anywhere else. I would just, without saying Mr Dixon's arrangement was the best, say we are very much indebted to him for the paper he has given and the trouble he has taken. (Applause.)

Mr DIXON—I have to return my thanks for the cordial manner in which you have received my paper. I may say the primary object I had in designing the screen was to make a mechanical riddle. I had all the arrangement made for that purpose—to shake it backward and forward—but I found it would not work in practice, and I abandoned it and went in for the star-wheels instead. With regard to the mechanical screening, my experience is a very important one, viz. :—that it is appreciated by the coal consumer, and that is the main thing. (Applause.)

A DESCRIPTION OF TWO MODES OF WORKING THICK SEAMS OF COAL IN THE WISHAW COAL FIELD.

BY MR THOMAS BORLAND.

IN bringing this paper before the Institute, the writer does not pretend to set forth any new principles of working, but simply to elicit the opinion of the members ; and should he succeed therein, his aim will be secured.

The working of coal, like the ventilation of mines, is one of the most important branches in the art of mining. While considerable attention has been given to the latter, an equal study has not been given to the former, and to this alone may be attributed some of the most disastrous results in the annals of mining. We may have the most modern appliances for produc-

ing ventilation; but, unless the workings of the colliery are conducted on the most approved principles, the ventilation fails, and the safety of the workmen is imperilled. It is no uncommon thing in the history of mining to be startled with the news of an explosion having taken place, resulting in the loss of large numbers of workmen, and, strange to say, the ventilation is reported as being good. The appliances for producing ventilation may be excellent; strong currents of air may be circulating in the roadways, but, when an explosion does take place, and the lives of large numbers are sacrificed, the workings of the colliery are at fault, and no system of ventilation will suffice to give safety. Therefore, the workings of every colliery ought to be conducted on such a principle, that should an explosion take place in any part of the mine, it would be confined to that particular division, and under no circumstances be allowed to extend beyond it.

With this aim in view, it is proposed, firstly, to show the disadvantages which arise from working coal by stoop-and-room, as compared with a system of working thick seams of coal practised for some time by the writer, and believed by him to have some practical advantages. In doing so, it will be convenient to classify it under the following heads, each one of which ought constantly to be under the attention of the manager:—

1st. To extract as great a proportion of coal from a given area as possible.
2d. To produce the coal round, and in a good marketable state.
3d. The securing of good ventilation, so as to render explosions impossible.
4th. To reduce the use of gunpowder in mines, more especially fiery ones.
5th. The reducing of accidents from falls of roof to a minimum.
6th. Economy; and under this head may be classed the workmen's wages, material, &c., although all the foregoing heads are embodied therein.

Firstly.—Stoop-and-room is generally the system adopted of working out thick seams of coal. By it stoops are formed 12 yards square and upwards, according as the depth from the surface

varies, and the working places are usually from 6 to 12 feet wide. Sometimes the forming of stoops and driving places are continued from the shaft onward, until the boundary is reached, which may require years to accomplish; then stooping is commenced from the boundary, but pillars of coal exposed to the action of the atmosphere for years, deteriorate, become dried and friable, although left large enough at first working to carry the weight of the superincumbent strata; and it is often found after the lapse of years, during which time stooping has been going on, that they become crushed, and are unable to sustain the pressure, because the weight from the stooping going over them forms a creep. When this takes place the roof falls around tbe pillars, the roadways become filled up, and the pillars can never be all extracted. In this way whole stoops are often lost, and in many cases large areas of pillars have been completely buried up.

To avoid this difficulty many plans have been tried. One known as the panel system, is the dividing the mine into separate divisions, as shown at A A A A (Plate XVI.) In this panel the working places and stoops are the same as in plan No. 1, viz., 12-yard stoops and 12-feet places (this being considered the minimum size for stoops and maximum width of working places). By this method the pillars are never long exposed, no falls take place in the workings; the stoops in this area being worked out as soon as formed, at the same time care being taken to work out every stoop, and allowing nothing to stand that would hinder the roof from subsiding within the panel. This alone prevents the weight from extending to adjoining panels, and in working thus the total quantity of coal in any seam may be nearly extracted.

Secondly.—By working, as shown in Plates XV. and XVI., the dross made in first working will be equal in both cases, but very different will the results be when stooping; the stooped coal in panels A A A A will be as good in quality as coal worked from the solid, while at the same time the dross produced will be considerably less; if the dross in the first working be in the proportion of 1 to 2 of coal, or $\frac{1}{3}$, it will be found that by carefully and expeditiously extracting the pillars, the dross may be reduced to $\frac{1}{4}$. Whereas, by working as in Plate XV., the stoops become more friable as you retire from the boundary, the dross is increased

and oftentimes (in soft coal) becomes one-half of the total quantity produced, and this is not all, for the coal is reduced in quality by long exposure, and its volatile constituent is being constantly evaporated, impregnating the atmosphere we breathe. It is this evaporation that causes stooped coal to be of less commercial value, because one of its component parts (hydrogen), the most combustible of its elements, has been partially decomposed.

Thirdly.—To secure good ventilation, every colliery ought to be divided into separate divisions, each division ventilated by a current of pure fresh air direct from the downcast, and returned direct to the upcast, and in no instance be allowed to ventilate a second division. Again, each division ought also to be provided with a separate exit for any gas that might accumulate in the goaf, which is shown at W W, Plate XVI. By having this roadway open to the action of the ventilation, gas will escape thereat, which otherwise would escape where the men are working, and become a constant source of danger. In this way, the ventilation also becomes more simple, for a greater area of airways are open to the currents. It is therefore plain that a diminished velocity will supply an equal amount of air, because the length of air passages is considerably shortened, and as the power required is in proportion to the lengths of the air passages, and the square of the velocity of air currents, so, in like manner, is the cost of ventilation increased or reduced.

When working on the principle as shown in plan No. 1, the same facilities is not afforded for producing good ventilation; extensive areas are opened out and left in pillars for years, falls take place in the workings, gas accumulates on the top of these falls. Then it becomes necessary to ventilate the area standing in pillars, which considerably lengthens the air channels. The goaf becomes a reservoir for gas discharging into the air currents near the workmen. The consequence is that the currents of air become more sluggish, dangerous, and insecure.

Fourthly.—In nearly every mining district where stoop-and-room workings are adopted, the miner generally when working solid places has to resort to the use of blasting material, the cost per ton of which will vary in different districts, but may safely be computed at one half-penny for coal produced from the solid.

In some districts it costs as much as one penny per ton. By working as shown in Plates XV. and XVI. the proportion of solid to coal left in pillars is about 44 per cent. of the former, to 56 per cent. of the latter; or, in three acres of coal 6 feet 8 inches thick; the cost of blasting material at the above rates will be £26 12s 6d, or for an out-put of 300 tons per day of solid, 12s 6d. Of course, it may be said, that this is payable by the workmen, but sooner or later the employers have to reimburse it, for in collieries where it is not required, a lower rate per ton is paid. Therefore, it is our duty to adopt a different system of working, if by doing so we may reduce the quantity used, for every pound of blasting material saved is so much gain to the employer, and a proportionately greater safety to every one employed underground.

Fifthly.—The main roads of every colliery are always more or less secured in accordance with the nature of the roof. Accidents from falls therein though few, generally take place while men are in the act of repairing some part of the road. If care and skilful workmen only are employed they might easily be prevented. It is only at or near the working places accidents from falls of roof are frequently recorded, and, as a remedy, it has been suggested that the enforcing of a definite system of setting props would have the effect of preventing a number of them, which no doubt it would, but so long as the present system of driving wide places, and opening out extensive areas and leaving it in pillars is adopted, no real cure will be effected. Irrespective of the cost of setting a plentiful supply, the props soon decay, and are not available for working out the stoops. When they do decay the roof breaks in the roadways, and when stoops come to be extracted the same immunity from danger is never obtained. I believe we need only look for a diminution in the number of these accidents from a system of working whereby it would be to the advantage of the employer to enforce a definite rule, and at the same time whereby every prop then set could be available for working out the pillars.

Sixthly.—Workmen's wages may be classed as productive and non-productive, or miners and oncost men. By working in regular stoop-and-room the difference in cost per ton for solid and stooping at present rate of wages may be taken at 4d or 1s 2½d

and 10½d per ton respectively, and as the proportions are 44 and 56 per cent. ; we may assume that 78 per cent. of the coal in pillars is gained by second working, which will be equal to 88 per cent, of the total quantity, or a mean of 1s 0½d per ton. By working in panels and stooping, as shown in Plate XVI., these proportions may easily be obtained ; if working as shown in Plate XV., the solid rates will be as above; but as the stooping advances from the boundary, in many cases the roadways are fallen. The stoops are not so easily worked, and if there is a bad roof to contend with, the cost per ton may be as much as at first working.

Non-Productive Work.—Under this head arises one of the most difficult questions the manager has to deal with. To ensure economy, the following ought to be kept in view :—Keep good roads, so that where horse power is used they may be able to go with a full load; take advantage of gravitation wherever available ; have few main roads to keep ; when roads are laid down by the miner at first working the stoops so far as convenient ought to be extracted before ever the roads are lifted ; see that the workmen set the props in a systematic manner ; if this is strictly attended to there need never be a fall to "redd" in the workings while stooping; a like reasoning applies to material. No greater waste of material can be than lifting and relaying roads unnecessarily, driving wide places, and having to set two and sometimes three rows of trees therein, allowing pillars to stand for years unworked, for the trees decay, and the roof falls ; when this is so, no amount of prop wood will suffice to give safety while stooping.

To remedy some of these disadvantages, after careful observation, aided by the writings and opinions of different authorities, the following system was adopted :—

In describing it, it is necessary to say that the seam is known as the Main and Pyotshaw, both seams being together. The coal to the north of the field was 7 feet thick surmounted by 8 feet of fire-clay and balls, increasing in thickness as we advanced toward the southern boundary. Above this is a thick post of sandstone known as the Wishaw Rock.

In 1874, the workings were conducted on what is known as the

stoop-and-room principle—stoops 12 yards square ; working places, 12 ft. wide. There was from 12 to 18 inches of coal left on for a roof. Though two rows of trees were generally set in the roadways it was not long until these gave way, and when stooping was commenced many of the pillars were completely buried, the "redding" out of which became costly. The coal could not be all worked out, and it was very difficult to get the wood properly withdrawn.

But narrow places with no trees and long rances instead of square stoops proved a complete success. The rances were formed across the dip and rise of the strata, this being at right angles to the plane of the coal ; by 12 yds. on the end of the coal. Places put through for air were never more than 6 feet wide. The mode of working will be understood by referring to Plate XVII., and may be stated thus:—After the rances were formed, two men began at the end of one of these rances and undercut it to the depth of 3½ feet, the full length across, viz., 12 yards. It was supported (the part undercut) every 4 feet with "gibs" of wood. These were taken out, and two holes bored, each at a point 12 feet from the side of the rance, and each charged with six inches of powder. When exploded, the coal from one end of the rance to the other was brought down. Fillers were then deputed to fill at a fixed rate per ton. This continued for several days, when it was found that we could with safety work the whole seam, leaving nothing to support the roof, though fire-clay. The following are the details :—One cutting 3 feet thick came off each rance regularly, and filled away. (If the rance was allowed to stand for a day or two, the roof always broke around the props and along the face.) The roof was supported by 5 inch foreign props set at 3 feet from centre to centre, all in regular lines, with a 2 inch soft wood lid. This necessitated us setting a row of props every day. When six rows were set, the three back rows were withdrawn, leaving three rows to support the roof along the face. It was rarely a single tree was broken or lost; the thick lids acted most admirably in preventing them breaking. When withdrawing the props, if a prop would not come out easily with the wood hammer (which they seldom would), the roof was cut above it. This prevented them from being wasted

at the ends. On one occasion, 80 trees, 6 inches thick, served to work out, on the above principle, four pillars, each 12 yards square, with 6 feet opening between, or a total of 1150 tons—not a single ton of coal being lost, and many of them were available thereafter, the success of which I can only attribute to the skilful manner in which the props were set by the miners and withdrawn by the officials. The result of the above was that the stoops were let to contractors at a six-ton darg. Often, I might say regularly for several months, two contractors along with two fillers produced from 60 to 72 hutches per day of 10 cwt. each.

The proportion of dross was greatly reduced. The coal was all extracted with a great saving in wood. There never was a crushed stoop, and not a single fall took place between the rances. While by the old system the darg was from 4 to 5 tons per day, the dross was about one-half of the quantity produced from the stoops. The coal was never all got out. Wood could not be well withdrawn. Every stoop was crushed, and redding had to be resorted to before working them.

But, as we worked southward, the roof gradually assumed a more hardened nature in the form of faik. When approaching the southern boundary, it became hard faik, alternating with very hard plies of sandstone from 3 to 12″ thick, and of a total thickness varying from 20 to 30 feet, to the bottom of the Wishaw rock as aforementioned. It was now that the skill and energy of the workmen in setting and withdrawing the props was taxed to the utmost, the roof being so hard, several times the props were unable to break it off, and had to be allowed to fall into the face of the rance.

One noteworthy feature was here remarked—when props were set and withdrawn several times, they lost their strength. If a considerable number of these were set in any breaking, the roof always came to the face; if fresh props were set, the roof could always be broken off, though at the expense of breaking a few in the back row. Scotch fir props were tried in one instance, and proved a complete failure; not a single tree was saved.

This system was continued upwards of three years until the section was worked out. Throughout the whole time, not a single individual was injured from falls of roof, though there were many

unseen "lipes" and saddle backs—a result which can only be accounted for by a definite system of setting a plentiful supply of prop wood.

In 1880 the system shown in Plate XVII. was tried, the roof being of a very strong nature. One rance, 70 yards long by 30 yards, was formed. Four men were engaged to undercut at a fixed rate per square yard, their day's work being to undercut 6 yards each, 3½ feet deep. Four men were employed to take down, fill and secure the roof. One road passed along the face from the under-end of the wall, which was lifted and relaid as occasion required. As there was a fast-end, two yards were allowed for side-cutting, the wall being 22 yards long, and produced about 46 tons, which required to be filled away regularly. But in this case there were 10 inches of ground coal known as pugs, which was very difficult to lift, occupying the whole time of one of the four men engaged as fillers. This cutting was carried forward 16 yards, and the wood withdrawn. Cutting after cutting was taken off in this way until the rance was finished, and proved successful. The cuttings shown in Plate XVIII. and figure 2, Plate XXI., are 16 yards long, and are preferable to one 22 yards, as we afterwards found, for the same waste is not opened out at one time. Fewer props are required, but an increased side cutting is necessary.

A comparison numerically of the method shown in Plates XVII. and XVIII., as compared with that shown in Plate XVI., may not be uninteresting. For this purpose, I have made the area of panel A A A A exactly 3 acres, and to simplify calculations, the coal is taken at 6 feet 8 inches thick, or two tons per square yard. By working as in Plate XVI., the solid is 44 per cent. of the whole, and if 78 per cent. of the coal in pillars is thereafter gained, it will be equal to 44 per cent. of the total quantity in the 3 acres, or a total of 88 per cent.

In 3 acres the total in tons = $4840 \times 2 \times 3 = 29{,}040$; and 4 per cent. being from solid, will be equal to

$\frac{29040 \times 44}{100}$ = - - - - - - - -	12,777·6	tons,
and 44 per cent. from stooping will = - -	12,777·6	tons,
Or, from a total of 29,040, there is worked, -	25,555	tons,

which shows a loss of 3485 tons in the above area. Fig. 1, Plate XXI., will show the method of stooping from which the above per centage has been calculated.

By working as shown in Plate XVII., the whole coal will be easily extracted. And, as shown in Plate XVIII., the coal lost will not exceed 900 tons, and if worked regularly might be reduced to 600 tons. By referring to Plate XXI., Fig. 2, it will be understood, but may be explained thus:—A dotted line is seen in the centre of each rance and pillar, the coal in working over from the right is taken out to this line, and working from the left 2 feet of coal is left to support the roof, while withdrawing the wood, which will entail a loss of 600 tons; if 3 feet of coal is left, 900 tons may be lost. If the latter quantity, this gives a total of 29,040—900 = 28,140 tons worked from the 3 acres.

Let us now examine this carefully from a financial point of view. Firstly, I may say that the main roads of every colliery are nearly alike, and paid at so much per ton, and an allowance per fathom; therefore need not be taken into account, nor yet the workings shown in Plate XV., for the reason already stated, viz., that the stooping often costs as much as at first working.

In Plate XVI., the solid produced from 3 acres is 12,777·6 tons, and 12,777·6 @ 1s 2½d per ton, = nearly	£772	0	0
And from stooping, 12,777·6 tons, @ 10½d per ton, = - - - - - - - nearly	559	0	0
Total, -	£1331	0	0
In Plate XVII., the solid produced in each panel will be 5652 tons, and 5652 @ 1s 5½d per ton, = - -	£412	2	6
(3d per ton being allowed for working narrow places.)			
And from rances, 23,388 tons, @ 10½d, = - -	1023	4	6
Total, - -	£1435	7	0

Or, for working out the total quantity, 29,040 tons, £1435 7s, whereas for working 25,555 tons in the former case, the cost is £1331, and by direct proportion, if 25,555 cost £1331, what will 29,040 tons cost? which will be equal to £1512 10s, or a

balance in favour of rances in working cost of—By

stoops, - - - - - - - - - -	£1512	10	0
By rances, - - - - - - - - - -	£1435	7	0
Difference, - - - - - -	£77	3	0

Let us next see what may be done in the way of reducing the proportion of dross.

By working regular stoop-and room the proportion of dross is taken at one-third, and for 29,040 tons there will be 9680 tons of dross and 19,360 tons of coal. But by working narrow and forming rances, the dross in the narrow work may be taken at 1 to 1½ of coal, and for the quantity taken formerly, viz., 5652 tons, there will be 3391 tons of coal, and 2261 tons of dross, but working from the rances, the dross will easily be reduced to one-fourth, which will be 5847 tons of dross, and 17,541 tons of coal, or a total of 8108 and 20,932 tons of dross and coal respectively. And as compared with the above will be equal to 20,932—19,360 = 1572 tons of more coal, and 9680—8108 = 1572 tons of less dross, in the panel or area of 3 acres.

Again, if the market value of coal is 5s per ton, and dross 1s 6d per ton, the value in the

former case will be 19,360 @ 5s = - - - -	£4840	0	0
And 9680 @ 1s 6d = - - - - - - -	726	0	0
Total, - - - -	£5566	0	0
In the latter case, 20,932 @ 5s = - - - -	£5233	0	0
And 8108 @ 1s 6d = - - - - - - -	608	2	0
Total, - - - -	£5841	2	0

Which shows a balance in favour of rances for dross alone of—

By rances, - - - - - -	£5841	2	0
By stoops, - - - - - - - - - -	5566	0	0
Difference, - - -	£275	2	0

Again, if looked at from the landlord's standpoint it will be as under:—When the rental is 1s for coal and 3d for dross, as there was 25,555 extracted from the 3 acres, one-third being dross, there will

be 17,037 tons of coal @ 1s = - - - -	£851	17	0
And 8518 tons of dross @ 3d = - - - -	106	9	6
Total, - - - -	£958	6	6
And by rances, 20,932 tons of coal at 1s = - -	£1046	12	0
And 8108 tons of dross @ 3d = - - - -	101	7	0
Total, - - - -	£1147	19	0
Which indicates a difference in favour of the landlord of—By rances, - - - - - -	£1147	19	0
By stoops, - - - - - - - -	958	6	6
Difference, - - -	£189	12	6

Or equal to £63 4s 2d per acre.

A few words may now be said under the third head of this paper—the securing of good ventilation. By referring to Plates XVII. and XVIII., it will be observed that each division is ventilated by a separate current, returned direct to the upcast. There is also a return airway at W.W. for carrying off any gas discharged from the roof when subsiding. This will at all times prevent gas from accumulating in the goaf. One thing of very great importance is secured by working thus:—In many mines gas is found to be pent up or stored under great pressure in the strata above, and at times below the seam of coal; and to prevent this from escaping into the air channels, the earliest possible opportunity ought to be taken of allowing it to escape, which can only be effectually done by allowing the roof to subside. In concluding under this head, I would say if reasonable care is taken in ventilating these panels, there need never, under ordinary circumstances, be an explosion; but should an explosion take place it could not possibly communicate to a second division, and consequently the greatest number of miners that would be affected would be those working in that division, and need not at any time exceed fourteen.

Under the fourth head, it will be observed that the use of gunpowder will also be considerably diminished. As before shown, while working solid by stoop-and-room the cost of gunpowder for working 3 acres of solid, at 0½d per ton, was £26 12s 4d,

and for opening out the same area into rances it would be £11 15s 6d—or a saving in money of £14 16s 10d. But the gain derived from a diminished use in blasting material, in affording greater safety to those employed underground, cannot be overestimated.

Fifthly.—The accidents from falls of roof will also be considerably diminished. As fewer roadways are opened out, and the roads are of less width, therefore the roof has not the same tendency to fall. The manager also has every encouragement to enforce a definite system of setting props, whether the roof be hard or soft; because a plentiful supply of props set in first working will give greater security, and every one of them will be available for working back the rances. Whereas, by working as shown in Plate XV. the props set in the working places generally decay before the stoops are taken out, which adds so much more to the cost per ton of mineral produced.

Sixthly.—Economy. Having already pointed out the advantages derived, I will only add that the foregoing results were obtained with no greater amount of work performed on the part of the workman, while his earnings were considerably more. The non-productive work of the colliery is also reduced. There is nothing but main roads to keep. The props set in first working will suffice to keep the roof in the workings while stooping, consequently there will be no falls to redd. There is no lifting and relaying roads unnecessarily, which will cause little waste of material, and the cost per ton for props will not exceed one penny if the system is regularly and judiciously carried out. In Plates XIX. and XX. is shown a pictorial view of the system adopted in setting props, while working from long rances as shown in Plates XVII. and XVIII.

The PRESIDENT—Mr Borland has given us his experience in various modes of working the main coal and pyotshaw together at a colliery which is not very deep. I think the depth from the surface is about 50 fathoms, and therefore I dare say many of you who are accustomed to the working of the ell coal will not be disposed to agree with the quantity of dross in working stoops as well as driving in the solid. Neither would you be inclined to make stoops 12 yards square; but you have here a

plain, unvarnished statement of matters, and the subject is really very worthy of consideration. I do not suppose at a depth of 150 fathoms, while taking out pillars, the dross would be less than in the solid.

Mr BORLAND—I say it is always more from pillars, but when formed into rances and worked by the method advocated, it is always less. Although rances be formed and the miners allowed to cut and fill the coal by the old system little advantage is gained, it is only by having a large area undercut at one time, allowing the action of gravitation to assist in bringing the coal down in large pieces that the benefit is derived.

Mr SIMPSON—The dross is most excessive, and if we could get any means to lessen the amount it would be most important.

Mr BORLAND—What I hold is the driving of wide places is one of the greatest follies, because the weight comes over and crushes the stoops, whereas if the places be narrow the weight can never come over into the openings of roads. In the workings shown in Plate XVIII. the roof was very hard—in fact few props were needed in the working; and I have no doubt that by working narrow and forming long rances you are able to work the hardest roof in the district, and the softest coal and the dross from the rances will be considerably less than from pillars. Of course the dross in the narrow places will be rather more from the extra side cutting.

Mr SIMPSON—I see in regard to your different districts and divisions, you say there is no communication between them, so that an explosion could not affect more than the one district or panel.

Mr BORLAND—There are only two openings to each district or panel.

Mr SIMPSON—Does that separate them? In the case of an explosion in one district, will it save any of the others? In Blantyre, I rather think, there were only two openings between Nos. 2 and 3 pits.

Mr BORLAND—Was the ventilation all in separate currents? because if an explosion were taking place in one of these it would not pass into the other.

Mr SIMPSON—There were just two roads communicating the two pits, and the blast went from the one to the other.

Mr BORLAND—The workings in No. 2 would be all connected one with the other.

Mr SIMPSON—I am telling you of a fact that did happen.

Mr BORLAND—Of course I do not misdoubt you, but still there is only the intake and return, and only one communication.

Mr SIMPSON—There was certainly not more at Blantyre.

Mr BORLAND—Was the pit in panels?

Mr DIXON—The same thing took place in the Pen-y-craig explosion. The blast went through a stone mine.

Mr BORLAND—If the air currents are all impregnated with carburetted hydrogen (marsh gas) it is bound to go, but the Mines' Regulation Act enforces a quantity of air to render harmless these gases. The danger is if it accumulates in the goaf.

Mr DIXON—I would not deprecate the plan of dividing the workings into panels. I suppose what Mr Simpson points out is, it is not an absolute guarantee to safety, but at the same time it may be precautionary.

Mr BORLAND—I understand there was only one communication at Pen-y-craig, and the effects of the explosion travelled through that narrow mine. There is not the least doubt if a large accumulation of gas be exploded, the effects of that explosion would be communicated to adjoining workings, although connected only by one or two passages. But the object aimed at in this paper is to have the workings on such a principle that this large accumulation of gas could not possibly take place, and to achieve this, the panels must be limited in area, have the coal nearly all in rances, with few narrow openings, consequently there will be little space for gas to accumulate; but should it accumulate in any roadway the quantity would be so limited that if exploded the wave of air caused by the explosion would be so feeble that it could not possibly communicate to adjoining panels. Whereas, I understand, the workings in Blantyre were very extensive, all connected one with the other by regular stoop-and-room workings, with perhaps a large accumulation of gas in the waste or area standing in pillars. If this is so, in any working the effects of an explosion will at all times be disastrous,

Mr GARDINER—Might I ask, as to Nos. 2 and 3, Blantyre, was the one a down-cast and the other an up-cast? Might that not affect it? Mr Borland, as I understand, ventilates the one panel, and gets a separate current, and returns it without intermingling with the others. In Blantyre did they not intermingle? Were the currents of Nos. 2 and 3, Blantyre, not mixed going to a common up-cast shaft? having a connection and being one and the same current, or parts of the same, thereby the means of connecting the explosion in the two pits, whereas, if I understand Mr Borland, he keeps the current separately to the up-cast shaft. I thought he was to carry his air back independently—I think he used that expression in his paper—to the up-cast shaft, and that was the reason for the separation, so that an explosion occurring in one part would not affect the other, at least so long as the shafts were not destroyed or injured.

The PRESIDENT—The point is that although there is a separate return from the panel to the up-cast shaft and a separate intake from the down-cast to the panel, still the effect of the explosion may act more on these than the panel itself.

Mr HASTIE—I do not quite agree with Mr Simpson in saying that at Blantyre there was but one communication. There were two communications. There were 17,000 cubic feet of air per minute going along from No. 3 into the workings of No. 2 Pit, and then there was the level road from No 2—that was two communications. Mr Borland says in his system of rances he reduces in stooping the percentage of dross to one-fourth. Now, in the Hamilton district, with stoops on an average of 25 yards square, 45 per cent. of dross would in that way of Mr Borland's be but 12 per cent. I would be very glad if that were the case.

The PRESIDENT—Mr Hastie, you have some very large pillars in your workings; have you less dross in them than in the ordinary pillars from 25 to 35 yards?

Mr HASTIE—No, I think the dross averages about 45 per cent.

The PRESIDENT—Even in those large pillars or rances.

Mr HASTIE—Just about the same proportion of dross. It is impossible the dross can be reduced down to a fourth in any system of working. That brings it down to, as I have said, 12 per cent.—a fifth of the Hamilton District.

Mr SIMPSON—Was the mode of panelling to save the dross, or was it for the ventilation?

Mr BORLAND—It was for the roof, which was soft, and to reduce the proportion of dross, not for ventilation, there being little gas in the pit.

Mr DIXON—There is a thing mentioned in the paper—that is, paying the collier so much a square yard for undercutting. Now, so far as my experience here goes, colliers will not undercut. They dig away at the centre and the head. If we could get the men to undercut and others to break it down, it might be an advantage.

Mr BORLAND—That is where the dross is made. When I was working stoop-and-room, and allowing the miners to cut and fill the coal there was 50 per cent. of dross from pillars, and it was partly to reduce that that rances were introduced. The men that undercut have nothing to do with filling. The fillers come after them in the day time; take down, fill the coal, and secure the roof; and I have no doubt if the ell coal were worked the same way, were undercut 3½ feet deep, and fillers were to come after the cutters you would reduce the dross considerably.

Mr DIXON—The difficulty with us is to keep the weight off the coal.

The PRESIDENT—The face assumes a semi-circular shape, and the pressure bursts the coal in the middle.

Mr BORLAND—That is because it is not worked quickly enough. If you work it slowly the weight comes on to the rances. If they were allowed to stand two or three days they were crushed by the weight, but by working them regularly—taking off one cutting every day—they stood perfectly well and were always hard.

The PRESIDENT—What is the average width of each "lift" of coal in pillars here—not more than five yards?

Mr LOVE—Not more.

Mr BORLAND—But they work them forward 20 and 25 yards. In fact they must carry that "lift" along the whole length of the stoops, 30 yards, and of course the weight comes on to the coal and crushes it.

Mr HASTIE—It will not crush them the least.

The PRESIDENT—The props are placed 2½ feet apart. I do not think that agrees with yours?

Mr HASTIE—We put them skin for skin. It might do well enough in Wishaw with 12 yard stoops, but it is of no use here, and the rances would be of no use, because the roof is very roughsome. Suppose it stood holed for a day or two it would not come down.

Mr BORLAND—I would just say this that there would be no use of trying long-wall in any field if you could not introduce this, because the principle I advocate here is simply a system of long-wall having openings at both ends of the rance or wall, and the working is so swift that the weight seldom gets forward on the coal. There are four men under-cutting and four men filling, that is 8 men in 22 yards.

Mr GARDINER—Consequently 3 yards a man.

Mr BORLAND—It was a 6 ton darg to each man,—48 tons per day.

Mr HASTIE—How much percentage of dross had you altogether?

Mr BORLAND—About 25 per cent. in the rances, but in the solid 1 to 1½.

The PRESIDENT, at this stage, suggested to Mr Borland that he might before next meeting visit some of the pits in the Hamilton district, and see the system of working adopted in them.

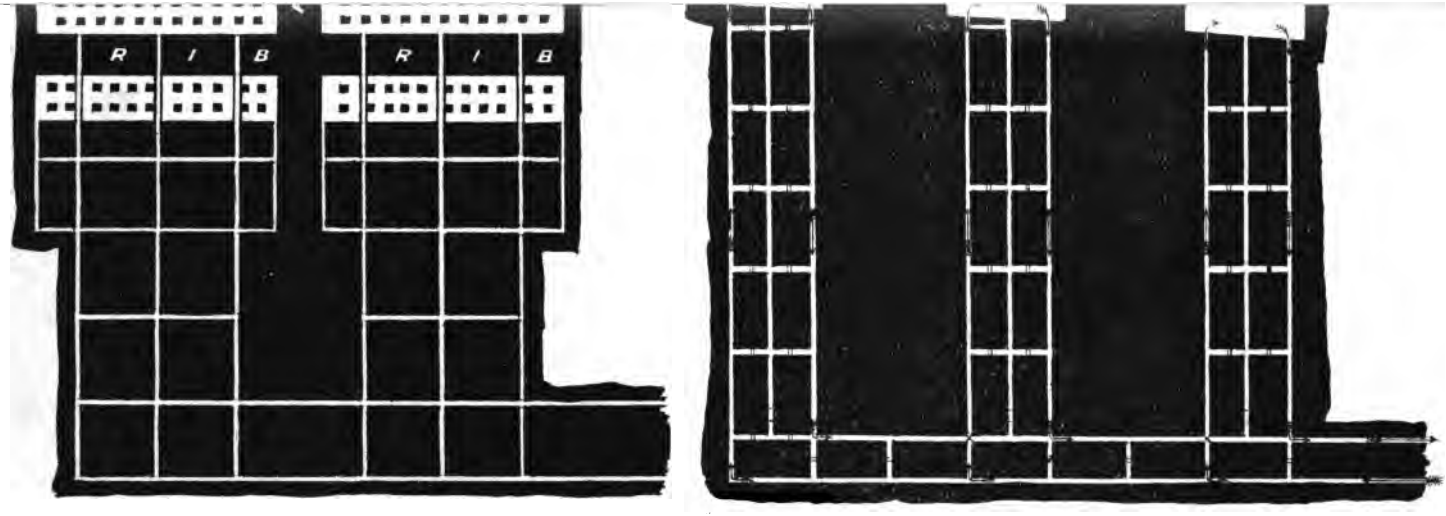
Mr SIMPSON said he would be exceedingly glad to show him the system of working, and if he could reduce the percentage of dross he would be very happy indeed.

Mr MORISON—It would be an extraordinary roof that would stand the system of working suggested. It would require to be a very fine medium between hard and soft. I have seen similar workings in a very low seam and hard top, and we could not get timber to stand. The system was not exactly similar, but it was a system that might be compared with this, and at a less depth than 50 fathoms.

The PRESIDENT—If you gentlemen have no other remarks to make upon this paper just now, I think we will adjourn the discussion upon it, and I hope before next meeting Mr Borland

will consider the working of it in the ell coal seam. It would enhance the value of his paper very much, and enable him to make any modification of it he thinks proper.

The discussion was then adjourned.



Scale 120 Yards to the Inch.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING, 17th MARCH, 1881,

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON.

RALPH MOORE, Esq., President, in the Chair.

THE SECRETARY read the minutes of the last General and Council Meetings, which were approved of, and signed by the President.

The following gentlemen were balloted for, and admitted as Ordinary Members :—

A. K. M'COSH, Ironmaster, Gartsherrie Iron Works, Coatbridge.
DAVID JOHNSTONE, Consulting Engineer, 12 York Street, Glasgow.
JOHN PARK, Manager, Stonelaw Colliery, Rutherglen.
THOMAS MUIR, Manager, Wester Gartshore Colliery, Kirkintilloch.
ROBERT GRANT, Manager, Limerigg Colliery, Slamannan.
ARCHIBALD THOM, Oversman, Bothwell Park Colliery, Bothwell.

Other five gentlemen were then nominated as Ordinary Members, and will be balloted for at the first meeting.

DISCUSSION OF MR BORLAND'S PAPER.

The PRESIDENT—We begin with the discussion of Mr Borland's paper to-night. Mr Borland has written a note saying he cannot be here to-night, but that does not very much matter, inasmuch as he will have an opportunity at the April meeting of replying to any discussion that may take place to-night. I have got one letter from a member who is unable to be present, who says :—

LLWYNYPIA COLLIERY, PONTYPRIDD,
GLAMORGAN, 14*th March*, 1881.

DEAR SIR,

In reference to the remarks made at the last meeting of the Mining Institute by Mr Borland, in answer to Mr Dixon, concerning the Pen-y-graig explosion, I venture to make the following remarks :—I was at the scene of the accident on the forenoon of the day on which it occurred, and had afterwards the opportunity of examining minutely the plan of the workings and the notes of one who had examined every accessible stall and road after the explosion ; and neither from these nor from the result of the inquest into the previous conditions of the pit could one discover evidence to show there was, nor in all probability could be, that fouling of the ventilating current by an explosive mixture which Mr Borland in one of his remarks seems to imply, if not exactly say, is requisite for the propagation of an explosion from one district of a mine to another. The experiments of Mr Galloway, late deputy inspector of South Wales, at this colliery prove conclusively, I think, to any unprejudiced mind, that an explosion may be propagated and spread with destructive energy by means of fine dry coal dust alone floating in the air and of that raised by the concussion of the primary explosion from the floor, sides, and timbers of a dry mine. So that I think Mr Borland will admit from his own conviction what in another paragraph he seemed forced by evidence alone to admit to be the case that, though workings may be divided into panels, one communication may serve to admit the continuation to another panel or district of an explosion from one otherwise distinct. I should feel obliged if you would put this letter into Mr Borland's hands, and express to him the pleasure with which I have just read his paper. Trusting he will pardon me if I have in any way misapprehended the purport of his remarks,—I am, yours truly,

JAS. GILCHRIST, Esq. JAMES H. RONALDSON.

P. S.—The results of his interesting experiments, at least his first experiments, were embodied in a paper which he read before the Royal Society a few years ago. J. H. R.

Mr GARDINER—In continuation of my remarks made after the

reading of the paper at last meeting—see page 241. I consider the text—or the description of the method proposed in the paper—is at variance with the accompanying plans, *i. e.*, on page 229, he states—"To secure good ventilation every colliery ought to be divided into separate divisions, each division ventilated by a current of pure fresh air direct from the downcast shaft and returned direct to the upcast, and in no instance be allowed to ventilate a second division." Again on page 237—"But should an explosion take place it could not possibly communicate to a second division." Referring to plan XVIII., I must say the arrangements are nice on the paper, but, should an explosion take place, where would the air crossings be? Any one built could not resist such pressure as they would be exposed to by an explosion—these on plan are shown as such. I turned up several authorities to see if any initial pressure were given. I only found that the combination of forces was so complicated as to be beyond calculation, but must be enormous. I fear Mr Borland has under-rated that pressure, in detailing his intake over or under his return, not only of the panel in question but of all those in the in-bye-side of it in case of an explosion. Again, I consider his return or gas discharge outlet at W W as dangerous. It might be of use, although open to question, if he applied the hints suggested in the *Nineteenth Century* of December last, by the sailors' friend, I mean the ex-M.P., Samuel Plimsoll, Esq. There are certainly some good points in laying off a colliery by the panel system, if the coal is known to be very fiery. Independent returns can easily be had, which are not open to the objections I have just referred to. Further, in fiery mines the rapid opening out of fresh ground means a rapid expansion of ventilating system, and consequently attended with much danger as most of you present know. Now, by this panel system the daily output of coal could be steadily maintained with a less rapid opening out of new ground, and, consequently, lessening the chance of sudden outbursts, or a heavy vitiating effect on the air current. It is an extremely difficult matter to lay down a system or method by which any two seams of coal could be wrought to best advantage by it, for example: the Main and Pyotshaw wrought by Mr Borland, and the Ell coal in this district. These seams cannot

be wrought, I think, to the same advantage by the same system, on account of the roof and pavement in the one case differing so much from the roof and pavement in the other. In discussing methods of working in future I would suggest a section of overlying as well as underlying strata should always accompany section of coal seam, it would enable parties who had only the paper to guide them to form ideas more correctly, for, I fear the nature of roof and pavement is not as much taken into consideration in devising methods or systems of working coal as it ought to be. I have gone over the figures given in the paper arithmetically and found them correct, except in the panels A A A A, said to contain three acres; there are four acres in plan XVI.

The PRESIDENT—Perhaps every member has not seen the *Nineteenth Century*; would you give the gist of Mr Plimsoll's suggestion?

Mr GARDINER—I give the quotation from the *Nineteenth Century*, in his own words.

"It (the fire damp) goes to the highest part of the pit, therefore, into the exhausted spaces I would work with this tendency, and as in the case of water, a large hole is dug called 'a sump,' to collect water at the bottom of the pit, and so facilitate its removal by the pumps; so I would make a hole or 'sump' for the accommodation of the gas; but, as the water is heavy and lies on the floor and has the 'sump' for it made in the floor, so my hole or 'sump' to gather the gas should be in the roof of the mine, and that in the highest accessible place. It is more certain that water will run into the hole or 'sump,' dug for it in the floor of the lowest part of the pit, than it is that the light carburetted hydrogen would rise in a 'sump' or hole, dug for it in the highest part of the workings of the pit. I would then place a vertical tube with an open trumpet-shaped mouth, something like the funnel or chimney of a locomotive in this place, and of such a length that the open mouth (which should be protected with a wire covering a cap to keep out the dirt) should reach up very near to the roof; the bottom end of this pipe or tube I should continue to the bank of the pit; and, as in the case of water, you proceed to remove the accumulation by a water pump; so in this case I would pump out the accumulation of light carburetted hydrogen by means of an air pump (probably a small fan like that used in foundries would do as well or even better)."

Mr SMART—To set the ball a rolling, I think somewhere about twenty or thirty years ago, it was understood that 12-yard pillars were almost sufficient, but experience has led us since then to make them considerably larger, and after the 12 yards were

abandoned 20 yards was taken up and even that size of pillar is not found sufficient to support the roof. Everything depends, of course, on the nature of the pavement and the roof as rega rds the size of the pillars, but I think there are very few of us here present that would follow out the system of 12-yard pillars advocated by Mr Borland in his paper. It has been found that creeps have come over the pillars and much coal has been lost. I think we are all at one now that pillars can scarcely be made large enough so that we can get the air properly conducted and our ventilation properly wrought. Therefore, I think, as a remark leading perhaps to other remarks from the members, that Mr Borland's system of 12-yard pillars is far too small.

Mr ROBSON—I think Mr Borland mentions 12 yards as the minimum size of pillars, and does not state that 12 yards is the size which he would adopt in every case.

Mr SMART—Unfortunately I was not present at the last meeting, but in reading over the discussion, I think our President said that the workings Mr Borland refers to were 50 fathoms. Now, I think even at 50 fathoms a 12-yard stoop is far too small.

Mr HASTIE—I would be inclined to have larger stoops than 12 yards square even at 50 fathoms.

Mr ANDERSON—I was wondering what size of pillars will be left in the narrow workings in that same district—I suppose from 12 yards and upwards. I have seen some stooping recently where the pillars were left 14 yards. Mr Borland makes reference to 50 per cent. of dross being got from the system of stooping that obtained before he introduced his own style of working. That might be so in the Colliery he was referring to, but in one not far from it the percentage of dross is not quite so large by nearly 20 per cent., though the percentage of dross is a variable quantity also. The width and the length of the scree has a good deal to do with it. I do not suppose that the Main Coal and the Pyotshaw worked together would give anything like the quantity of dross that the Ell Coal would do. At least, in my experience it does not do so; but I think it is possible with the stoops from 12 to 14 and 15 yards there would be nearly as good results obtained as by the larger rances Mr Borland refers to. At the depth and the nature of the roof he had to contend with, I think it is also

possible to work the stoops on the very same principle that he advocates, viz., holing along the whole face putting in gibs and sprags to keep up the coal, and when it is taken down and filled, drawing the props a certain distance back from the face, letting the roof come down. At most collieries the men cannot be got to support the coal properly while they are holing it, but with good colliers I think it is possible to do it. I have seen it done with very good results. Whether the larger pillars in the Main Coal and Pyotshaw would be an advantage is what I am not prepared to give an opinion upon.

Mr RONALDSON—With regard to this first head, as far as I can understand from Mr Borland's paper in reference to his panel system, he makes no reference to taking out that rib of coal round about the panels, and therefore I assume he proposes to leave it in. Now, I find by calculation that the coal left in round these panels forms about 25 or 26 per cent. of the whole. Perhaps he has meant to take it out, but I do not think he leads us to infer that from his paper, and if it is left in there is 25 or 26 per cent. of the coal lost without any attempt being made to take it out.

The PRESIDENT—I think on the first head we may assume that the size of pillar depends upon various circumstances of roof and pavement, as Mr Gardiner said, but that at any rate there should be a little more than 12 yards. But what I would like to point out is that the amount of round coal depends as well on the thickness and hardness of the coals themselves; and as Mr Anderson says you will have better results in the Main and Pyotshaw than in the Soft Coal. Mr Borland at p. 237 says under the old mode of working he had 17,000 tons of round coal and 8,000 of dross, and under the improved mode 20,000 of round coal and 8,000 of dross, making a balance in favour of the rances. Perhaps some of you gentlemen would be prepared to join issue with him as to the advantage to be gained in point of roundness of coal betwixt the rances and the larger pillars. It may be there is a good deal to be said as to the mode of working where the coal will stand to be holed and gibbed as Mr Borland in his very excellent sketches shows us here, but I suppose you will be inclined to say that very little of the Ell

Coal and much Main Coal worked here about would not stand to be holed in that way. Mr Anderson, I think you work long rances?

Mr ANDERSON—Yes; 60 yards by 30, but unless with the coal cutting machine we cannot take out anything like 30 yards.

The PRESIDENT—Upon this point, I expect you will say you cannot agree with Mr Borland in his estimate of the coal and dross, because we all know in the Ell Coal it is impossible to get any such results as those he speaks of. I think you will be inclined to say the proportions he gives there by stoop-and-room or by rances must refer to that particular coal in that particular colliery, and by no means can be held to be a general statement of the results in working coal.

I think we may almost dispense with any more discussion as to the benefits of stoop-and-room and rances, except to go on to the ventilation, where you will observe Mr Borland makes a very strong statement. At p. 227, he says:—"To secure" (reads). That is a result very much to be wished, but I am afraid we have scarcely reached that point yet. However, if you are of opinion that the system proposed by Mr Borland is more effective than that which we now pursue, I think it is right that this Institute should express itself fully on the point.

Mr HASTIE—If Mr Borland had been here, I would have liked to ask a question with reference to the ventilation.

The PRESIDENT—It does not put him the slightest about because he gets the benefit of the discussion, and has more time to answer.

Mr HASTIE—My point is this: I think Mr Borland has not experimented very much on the ventilation, and has not had very much boundary to experiment on. I was looking over the Government returns for 1879 and find that in the colliery with which Mr Borland was connected there were but 90 men and 22,000 cubic feet of air passing through the whole.

Mr ANDERSON—I think the fact of a small quantity of air circulating and few men being employed does not say anything against the management of Mr Borland at that particular place. (Hear, hear.) I have seen a less quantity of air than 22,000, and very nearly the half had to be returned back to the pit bottom,

because the men could not have worked in it if it had been allowed to go round the face. That happened in a pit in the Western District inspection, and with this small quantity of air, and is one of the best ventilated pits that could be seen anywhere. I do not know about this panel plan. I think it is a very good one so far, but there is a point in it I do not very well understand —W W at p. 237, and shown both on plan 17 and 18. At p. 237, he says:—"There is also" (reads). I think that is very likely to be the case. It will prevent it from accumulating in the waste, but after it is past W W he shows another current, a return from another panel, and I do not know, if it is foul and an explosion takes place, what is to prevent it from carrying the explosion into the return that is coming from that other panel. There seems to be more than one. There is one to the right hand side of the plan and another to the left hand side, and they are joined together before getting into the upcast shaft. I think it is very likely if a serious explosion were to take place it would communicate it into those other panels. If Mr Borland or any one sees how that will be prevented, I think it would be very good information for us to get to-night.

Mr RONALDSON—I thoroughly agree with what Mr Anderson has just said with reference to plate 16 or 17,—I mean the exit for the gas at W W. That may be all very well as an exit for the gas, but I think it prevents to a great extent that isolation which Mr Borland claims in his paper. As Mr Anderson has just said, I think it very probable, should an explosion happen where they are extracting those panels, it will flash back through W W and into these other panels where the men may be working, and an explosion might in this manner be propagated from panel to panel.

Mr SCHUMAN—I have not yet had the opportunity of reading Mr Borland's paper; as has already been stated, the Transactions reach us sometime rather close before the meeting, to enable some of the members to mature an opinion for the immediate discussion. I should like to know whether Mr Borland proposes to lead his isolated courses into the inside of the upcast separately, to prevent the probability of voluminous darts of fire damp and heated air being caught within the mine between the crossings of

strong air currents, meeting from the various courses previous to spending—as it may not be unreasonable to suppose that by pressure or friction between the gases and air currents a spark might be generated to cause ignition and a burst of fire. The atoms (carburetted hydrogen) fire-damp are very light—this gas is therefore very buoyant—and this high state of buoyancy may prevent friction and ignition by the ventilating current of air, even of a higher velocity than pointed out by Mr Hastie as of the colliery Mr Borland is connected with—hence his confident tone of safety. Mr Plimsoll, who has lately published a paper on "Explosions in Collieries," lays much stress on the dangers arising out of the buoyancy of these gases by moving back and forward, and the probability of being driven together with dangerous quantities, even with a single air-way, add to this that the nature of a gas current driven in a horizontal direction by another current the form of each, if seen, would be jagged at the ends and shaped like the clouds in the sky from any thinness of point up to any volume, and perhaps communicating with more distant parts by thin thread-like streaks. There is no safety from explosions until you are sure you have these gases floating upwards within the shaft.

Mr RONALDSON—May I ask if Mr Schuman ever saw or heard of fire-damp being ignited by concussion without coming in contact with a flame?

Mr SCHUMAN—The concussion creates the fire.

Mr RONALDSON—Without a spark,—by simple concussion?

Mr SCHUMAN—A concussion may cause a spark. I cannot tell you any case, but that is the nature of it.

The PRESIDENT—I do not think Mr Plimsoll will be held to be a great guide in these matters. He is a man without real practice, but with reference to Mr Schuman's remark as to streaks of fire, so to speak, running for long distances, there was a case where a streak of fire-damp was proved by Mr Robson and myself to have run for fully 300 yards, burning some men at the end of that distance. A driver was going along the road, and at a point on the road he ignited the gas, saw it run along from him in a straight line across a waste. Just by way of continuing the discussion, I should like to say a word as to how much I agree with

Mr Anderson in his remarks as to the joining of the return currents. But if complete isolation is desired, you must begin at the bottom of the downcast and end at the upcast. You can easily fancy an explosion taking place in the return where these two currents communicate, and the consequence would be that the flame would strike into both channels. The same will happen at the points where the splitting takes place at the intakes. Another point, which I have noticed in explosions,—I do not know what it may yet come to, but it is this: suppose that you have a downcast shaft and your levels go east and west from it. If you have an explosion coming out of one level and the other faces it at the other side of the shaft, to a certainty the force of the explosion goes beyond and does damage to the other level as well. Whether it be that you will take care to have some sharp turns or the air rushing against a dead wall on the opposite side of the shaft instead of the levels facing each other, I have an idea that a precaution of that kind will be beneficial. It is very well worth considering whether and how best you can isolate each current and each seam, what roads shall not unite, and, seeing that roads do not exactly face each other, I think that is perhaps a point which has not got the consideration it will by and bye get. With a great many of the splits on this plan, it would be impossible to get an explosion limited to the panel from the way it is laid out.

Mr GARDINER—It occurred to me in looking over this plan, (XVIII.) when I was writing these notes, that an effectual way of returning the air up through a blind shaft to a mine leading overhead to upcast shaft from one of these panels, which would be quite independent, if resorted to, would be expensive, unless a thin seam of coal was conveniently at hand to drive the mine in back to shaft.

The PRESIDENT—At p. 240, Mr Borland says: "But the object aimed at" (reads). So far as I can see, the tendency of Mr Borland's paper would be to liberate more gas, not less, than you will do at present, because he makes panels and gives them a larger area, and consequently you have the gas issuing from that larger area. I think it is very plain from the unfortunate explosions we have had these few years back that it is not the

quantity of gas, as the young gentleman who has written that letter clearly shows, which causes an explosion to be so destructive. The gas begins the explosion, but in all dry seams so much dust becomes ignited,—charred, burnt in fact. Another thing, we send in now such large quantites of air, necessitating large air-ways that we give immense opportunities, so to speak, for the gas in flame to go out, which it had not formerly. Hence, it is not an unlikely think to expect that an explosion in a well-ventilated colliery will be very disastrous. The very fact of its being well ventilated,—and it cannot be too strongly said,—renders it, when an explosion does take place, more destructive than it would otherwise be. I may mention I had occasion when in London lately to see some papers recording experiments, showing the effects of coal dust in explosions, and to meet Professor Abel, who abundantly proves that a mixture of 2 per cent. of gas in a dry mine, if set fire to, explodes and carries the effects of the explosion for any distance. I remarked to the Professor: suppose that you have got coal dust, the coal dust would be worse than if it were mixed with stone, and hence we might say that a long-wall would be safer as regards explosions than stoop-and-room, because you have only the fresh-cut coal at the face, and in the roads you have simply the brushing stone. But, unfortunately, he says it does not require coal, because he had experimented with slate,—pounded some slate very finely, and he had the same results as with the coal, so that with any dry dust or material an explosion might be rendered very destructive with a very small quantity of gas.

There is one point, before adjourning the discussion, I have to express the very great pleasure it has given me to look over the drawings by Mr Borland. I understand Mr Borland is a colliery manager. Really, whatever we may think of his paper his drawings are very creditable. The illustrations are plainly given in Plates 19 and 20; his perspective drawing exceedingly simply done, and yet how plainly they tell their story. I think they are exceedingly creditable to Mr Borland's industry and talent. I hope future readers of papers will take an example from Mr Borland.

The discussion was then adjourned.

HAULAGE BY ENDLESS ROPE AND CHAINS.

By Mr Malcolm MacFarlane.

Much has been written, and many valuable discussions have taken place by kindred Institutes, but as yet no paper has been brought before this Institute, except a short one by the writer during the first year of its existence, and before the papers were printed. In again bringing the matter forward it is hoped that others, who have had experience in the various modes of Haulage, will be induced to contribute papers, which cannot fail to enhance the value of the Transactions.

Within the last few years many improvements have been made in underground haulage, and these are still going on. Perhaps there are none present who can recollect the time when women were employed in some of our coal mines to carry the coals in creels on their backs from the face to the pit bottom, and thence by winding stairs to the pit bank. This primitive system of transporting coal was abolished by Lord Ashley's Act in 1842.

Prior to the introduction of cages and tubs, the coal was conveyed to the pit bottom in "slipes" or sledges, drawn on the pavement, and then emptied into corves, to be raised to the surface.

The next great improvement was to put wheels on the sledges, and these, now called "hutches" or tubs, were drawn to the shaft by young men called "drawers."

The introduction of horses and ponies soon followed, when the distances which the coal was drawn became considerable, and there was height of roadway to admit them. The next, and most important improvement, was the use of steam power, working stationary engines, and hauling trains of hutches by the aid of ropes, first hempen and afterwards of iron wire, and then steel. In some instances chains instead of ropes were used.

Another great improvement was the introduction of machinery driven by compressed air, thus dispensing with the use of steam underground or ropes in the shaft.

The details of the earlier methods of haulage by machinery are well known, and, therefore, require no description here. Examples of nearly every method can be seen in Lanarkshire and other parts of Scotland, but the system known as the "endless

chain" and "endless rope," especially the latter, has perhaps attained the greatest perfection.

A good example of the endless chain system is in operation at Dykehead Colliery, near Larkhall.

The following are some particulars relating to that employed for the haulage of the main coal, which has been at work about six years :—

The coal is won by an ingoing eye dipping 1 in 4·32 from the surface for a distance of 300 yards, then gradually reduced to 1 in 10 in the next 200 yards, after which the road is slightly undulating. The length of the plane is 1100 yards, which is in a straight line from end to end. There is also a side branch 400 yards long, which rises at the rate of 1 in 20, thus the total length of chain road is 1500 yards, and it is laid with a double line of common tram-plate rails throughout. The rails are 20ft. × 3in. × 1½in. and bracketed with straps. Along the centre of the empty road are laid beech planks 10in. × 1½in. to protect the chain and reduce the friction when touching the bottom. The engine is situated at the side of the railway on the surface immediately below the landing stage for the tubs. It is a single beam engine with a 16in. cylinder and 36in. stroke, geared by bevel wheels in the ratio of 3½ to 1 ; pressure of steam, 40lbs. The driving wheel is 4ft. diameter with horns all round 14 inches apart. The chain is of ¾in. iron, has a short link, and weighs 16lbs. per yard. It passes 2½ times around the driving wheel. The tubs each weigh 5 cwt. when empty, and carry a load of 8 cwts. They are provided at one end with a flat plate of malleable iron which projects 3 inches above the top of tubs, having a notch at the top, and into which the chain rests. The tubs are put on the chain singly, at intervals of 30 yards, making 35 loaded tubs and 35 empty ones attached to the main chain at once. The general speed is two miles per hour, which throws off 117 tubs per hour, or say 50 tons, or 400 tons per shift of eight hours.

The side-road being at an inclination of 1 in 20, and dipping with the full load, requires hardly any power to keep the chain in motion. The wheel at the termination of the main plane is similar to the driving wheel at the engine, and the chain passes 2½ times round it.

The driving wheel for the side branch runs loose on the same shaft, and is connected by a clutch when this chain is required to be put in motion. Without taking the side chain into consideration, the following calculations will give some idea of the work done on the main engine plane :—

Perpendicular rise = 268 feet, and this distributed over the whole length of 1100 yards, is equal to a rise with the load of 1 in 12·3. Speed, 2 miles per hour = 176 feet per minute.

Load of coal, $35 \times 8 = 14$ tons; or 31,360lbs, (Hutches. Cwt.)

and $\frac{31{,}360 \times 176}{12.3}$ (Lbs. ft. ⅌ min.) = ... 448,730 foot lbs.

Tubs, $70 \times 5 = 17{\cdot}5$ tons, or 39,200lbs., and (Tubs, Cwts.)

taking the friction at 1-70th $\frac{39{,}200\text{lbs.}}{70}$ = . . 560 foot lbs.

Chain, $2200 \times 16 = 15{\cdot}71$ tons ; or 35,200, (Yards. Lbs. Lbs.)

and allowing 1-20th for friction, $\frac{35{,}200}{20}$ = . . 1760 foot lbs.

451,050 foot lbs.

or 13·6 H.P. the work performed.

The labour attending this haulage, costs 14s 4d per day, made up as follows :—

			s.	d.
Man at Pit Bottom,	@ 3s 6d	per day, ...	3	6
Lad „ „	@ 2s 4d	„	2	4
Man „ Bank,	@ 3s	„	3	0
Lad „ „	@ 2s	„	2	0
Engineman,	@ 3s 6d	„	3	6
			14	4
The coal (dross) for engine and furnishings amounts to 7s 6d per day, ...			7	6

The cost per ton is for labour, ...	0·43	pence.
The cost per ton is for dross, &c., ...	0.22	„
Total per ton, ...	0.65	pence.

At Allanton Collieries, the Endless Rope System has been at work for upwards of five years.

At No. 1 Pit the engine is on the surface—it has an 18in.

cylinder with 4ft. stroke; pressure of steam, 40lbs. This engine works two endless ropes, one on the surface and the other for the underground haulage.

1st. The surface endless rope haulage, for hauling the wagons to their different stations; the driving drum is coupled on the end of the main shaft, fitted with a clutch which can be thrown out and in gear when required. The rope is $\frac{3}{4}$in. diameter, made of plough steel, and is 1500 yards in length. The rope, leaving the engine, passes round a 3 feet pulley, thence round the "stenting" carriage pulley, from which it goes direct to one of the roads for the purpose of removing the loaded waggons to the weighing machine. It lifts nine loaded waggons at once. The attachment is made by means of a "grip" (a model of which was shown), held by a man who walks along the side with the waggons. When weighed the waggons are drawn to end of the siding, a distance of 374 yards; the rope then descends the embankment to another road, where it is used for the purpose of drawing the empty waggons a distance of 390 yards.

The trains at this part are composed of six empty waggons. The rope then returns, taking the loaded waggons from No. 2 Pit to the weighing machine and then into to the sidings.

The dross made at No. 2 Pit is drawn from the weighing machine by a coupling chain to the siding, thence by incline to No. 1 Pit, a distance of 462 feet, rising 1 in 8. The undermentioned calculations will give an idea of work performed on this portion of the surface railway alone:—

	T.	C.				
Coal,	5	10				
Truck,	4	0				
	9	10	—or	21280 × 462 = 9831360.		
						Foot-Lbs.
9831360 ÷ 8 =						1228920
Ld. in Lbs.			Fric. of Ld.			
21280 ÷ 200 =						106·4
	Lbs.					
Ropes,	3360					
Rollers,	260					
	3620	÷ 20 =		Friction.		181
						1229207·4

Foot-Lbs

1229207·4 ÷ 33000 = 37·2 H.P. work performed.

The material used in erecting this haulage was entirely old, and I have estimated the cost of the wheels, &c., as follows :—

Drums, Soleplate, and Couplings, ...	£35	0	0
Groove Pulley, Soleplate. and Blocks, ...	5	1	8
38 Bevel Pulleys and Soles, 86 lbs. each, at 4s 6d per cwt., ...	6	11	3
19 Edge Pulleys, at 10d each, ...	0	15	10
54 Rollers, at 10d each, ...	2	5	0
1 Large Edge Pulley, ...	0	10	0
30 Cwts. of Rope. at 40s per cwt., ...	60	0	0
8 Three-feet Pulleys, at 20s each, ...	8	0	0
1 Five-feet Pulley, at 28s 3d, ...	1	8	3
Grip, ...	0	10	0
Maintenance during Four Years, ...	8	18	1
	£129	0	1

Previous to adopting this system of haulage, the cost of railway dues during four years for conveying dross from No. 2 Pit to No. 1 Pit was £486 13 4

And also a man and horse extra during winter months cost 187 4 0

The total cost being £673 17 4

Without taking in account the dross for engine and the proportion of engineman's wages, there is an apparent saving over four years of £544 17s 3d.

2nd. The arrangement of haulage underground :—The engine which works the surface haulage also works the underground haulage in the ell coal seam, and has already been described. It is fixed, for convenience of the surface arrangements, at a distance of fifty yards from the pit mouth. The engine drives, by bevelled gearing, a Thorncliffe pulley, 8 feet diameter, which gives motion to an endless rope or band reaching to a point near the bottom of the pit, where there is another Thorncliffe pulley. The band simply passes half a turn around this driving pulley on the surface. (Detailed drawings of the Thorncliffe pulley are given on Plate XXII.)

The rope on leaving the Thorncliffe pulley passes over a 6-feet pulley at the pit top, and under a 5-feet pulley at the pit bottom. It is then guided by a 3-feet pulley, and around a 5-feet pulley fixed on the straining carriage No. 1.

The straining carriage for the shaft band has a balance weight of 5 cwt. hanging over a 12-inch pulley in the ordinary way. On leaving the straining carriage it goes round a 5-feet pulley, which leads it on to the Thorncliffe pulley at the pit bottom, around which it passes ¾ of a turn, and returns to the surface. This is called the shaft band, or main driving band. The rope is 1⅛ inch diameter, and its length is 440 yards.

There are three distinct endless ropes working the underground haulage—a general plan of the arrangement is given on plate XXIII. Two of the ropes begin at the shaft, and the third at a point marked A. The total length of rope in all the bands is 4600 yards. No. 1 extends from the shaft to E and F, and is 3200 yards. It is worked by a 7-feet open C pulley, on the same shaft as the Thorncliffe pulley T—the rope passing three and a half times around.

On leaving this pulley it goes round a 3-feet pulley fixed on the straining carriage No. 2. The straining carriage has a weight of 6 cwt. hanging over a 12-inch pulley, and returns round a 3-feet pulley, giving it a straight lead for the empty road; it is carried along the road on rollers and small pulleys, 9 inch long by 5 inch diameter, and 18 inch long by 5 inch diameter respectively, and small edge pulleys 8 inch diameter. The latter are the same weight as the 18 inch rollers, and although they cost 6d more they are much cheaper in the end, as one pulley will last as long as six rollers where suitable. This rope is ¾ in. diameter, and is made of best plough steel; it has been at work for 23 months without any repairs, with the exception of being once spliced.

The hutches are hauled in sets of from 9 to 18, and are attached by means of a bogie, in which is fixed a pair of tongs worked by a screw. The mouth of the tongs are 6 inch broad, "ovalled" at each side so as not to injure the rope. The rope is taken round the curves at B and C, which have each a radius of 35 feet, with bevel pulleys 11 inches diameter set to the same pitch as the mouth of tongs to allow the rope to drop back to its former position after the bogie has passed. The sets taken from E consist of 18 hutches. At the point two chains from C on the road the gradient is 1 in 6, and the work done is greater here

than on any other part of this road. When the rope is travelling 240 feet per minute, the following calculations will shew work done :—

18 hutches @ 14 cwt. = 28224lbs	Foot lbs.
Load 28224 × $\frac{240}{6}$ = ...	1128960
Friction of load, 28224 × $\frac{1}{70}$	403
Friction of rope and rollers 4000 × $\frac{1}{20}$	200
	1129563

1129563 ÷ 33000 = 34·0 H.P work performed.

From the point F the load consists of nine hutches, at one part of the road, four chains in length, the gradient is 1 in 6 and the work performed here is as follows :—

9 hutches @ 14 cwt. = 14112lbs.	Foot lbs.
Then load 14112 × $\frac{240}{6}$	564480
Then friction of load 14112 × $\frac{1}{70}$	202
Then friction of rope, rollers, &c., 4000lbs. × $\frac{1}{20}$	200
	564882

564882 ÷ 33000 = 17.1 H.P.

On the third branch road, from A to H, the rope is worked by that on No. 2 road in the following manner:—this rope passes two and a-half times around a 5ft. pulley at A, and on the same shaft there is a 7ft. open C pulley which gives motion to the rope working the branch from A to H. It passes two and a-half times around the latter pulley, and half round a 3ft. pulley and then on to the straining pulley fixed loaded with a weight of 4 cwts. The rope then returns round a 3ft. pulley which brings it to a straight lead for the road taken round the curves G and down to H. On this plane 9 tubs are brought out at once travelling at the rate of 200 feet per minute, the gradient being 1 in 9 rising with the loaded hutches. The work done here is as follows :—

9 hutches @ 14 cwts = 126 = 14112 lbs.	
Then load 14112lbs. × $\frac{200}{9}$	313600
Friction of load 14112 × $\frac{1}{70}$	202
Rope, rollers, &c., 1750 × $\frac{1}{20}$	87
	313889

313889 ÷ 33000 = 9.5 H.P.

At this point there is a Warner's pump with three 5-inch rams. This pump is worked by the rope, which passes one and a-half

times around a 6ft. open C pulley geared to the pump. It forces the water collected at this point a distance of 900 feet or 40 feet perpendicular. The stroke is 10 inches and the speed 35 strokes per minute, the three rams discharging 3,504 gallons per hour. The pump is fitted with a clutch, so that it can be used or not at pleasure.

No. 4 Band works the road from the shaft to a point 350 yards on the opposite side of the shaft. It is also worked by a 7ft. open C pulley on the same shaft as T, the rope being two and a-half times round. It is fitted with a clutch so that it can be put in or out of gear when wanted. The empty rope leaving this pulley goes half round a 3ft. pulley and round a 3ft. pulley on the straining carriage No. 4, having a balance weight of 5 cwts. suspended. When the rope leaves the straining carriage it goes half round a 3ft. pulley, which brings the rope to a straight lead to the main road. The length of this band is 700 yards, rope is $\frac{3}{4}''$ diameter made of improved steel.

At the extreme end there are two pulleys, one $4\frac{1}{2}$ feet and the other 5 feet diameter, on the same shaft; the rope being two and a half times round the $4\frac{1}{2}$-feet pulley, transmitting power to the 5-feet pulley on the top. On the latter there is a band, 125 feet long, passing round one and a half times, and working a pump, No. 2. This pump is a double-acting one, with a 4-inch ram, fitted with a 3-feet wheel and balance weight of 2 cwts. Stroke of pump is 12 inches, and the speed 25 strokes per minute, delivering 1,281 gallons per hour.

At the extreme end of this rope is No. 1 Station, and at a point 150 yards nearer pit bottom is No. 2 Station. The load from these points consists of twelve hutches, and the gradient leaving No. 2 Station is 1 in 9 against the loaded hutches. When sets are being taken from E., F., and H. at the same time, the most work is performed on the Nos. 1 and 2 Roads.

At E.,	...	...	...	34·0 H.P.
At F.,	...	...	...	17·1 H.P.
At H.,	...	...	...	9·5 H.P.
Or a Total of			...	60·6 H.P.

Previous to the introduction of the Thorncliffe pulleys, there were two drums on the surface, 8 feet 6 inches and 6 feet 6 inches

diameter respectively, with five turns on the driving drum and four turns on the reefing drum, and the same in the pit bottom, the rope being put on in the figure eight, to prevent it slipping. When the loaded hutches were lifted simultaneously at all these three points referred to, the result was that the rope slipped on the drums, causing a stoppage of work. When this took place some of the bogie men had to let go the rope, and this occurred perhaps several times each day. The same conditions exist at the present time, but with the new system this difficulty has been overcome. With half a turn on the Thorncliffe pulley at the engine there is no slip, and it is believed that the rope would break before a slip could take place.

The cost for drawing the coal from all the different parts of the pit when horses were employed was from 8d to 10d per ton. In the same way with the endless rope system, including horses at the coal face taking hutches forward to the rope, the cost is 2·9d.

There is also a third pump (No. 5) wrought by the endless rope. It is a double acting one with a 2-feet stroke; diameter of rams, 5 inches; speed, 25 strokes per minute; and delivers 5,100 gallons per hour. Power is transmitted from the main band by having a 4½-feet open C pulley (No. 6) on top, with two and a half turns of the main band around, and a 7-feet pulley (No. 7) on same shaft, with half a turn of rope, and fitted with a clutch so as to throw it out and in gear when wanted. The pump is fitted with a 3-feet pulley, on the same principle as the 7-feet pulley, with half a turn of rope. This is a single ram, double acting, but can be made with two rams, double-acting. The total quantity of water thrown by all three pumps is 9,885 gallons per hour. You will therefore see, from particulars given, that the haulage of coal by endless rope is not the only advantage derived. There is also the pumping of water, which could not be done by men or horses, except at very great expense.

DISCUSSION.

The PRESIDENT—This is a practical paper by a practical man. The Thorncliffe pulley is an exceedingly simple thing, and very

well worth your looking at. I have no doubt but it will yet be very much adopted. The credit of bringing it into notice here, so far as I know, is due to Mr Austine, who is always in search of these novelties. I have been told of another with a piece of india-rubber in the bottom of the V. It is in use at Solsgirth, and although I have not seen it, I see nothing to hinder it working well.

Mr ANDERSON—It is also in use at Castlehill, Carluke.

The PRESIDENT went on to mention that there was a very fine example of chain haulage at Bo'ness.

The PRESIDENT, continuing, said he had no doubt as to the accuracy of the figures quoted in reference to the cost of haulage. He also mentioned that at Mr Wilson's colliery at Shawfield there is a long endless rope, but there the tubs were not drawn in such long trains as had been described, but four or five at a time without any attendant. Of course this system could not well be worked in so many branches as in the case Mr MacFarlane has described, but it showed how the system of rope haulage can be more easily applied than chain haulage, which requires a dead straight line. For example, at Bo'ness, from circumstances connected with the march, they were obliged to deviate from a straight line for more than 20 yards, and they had to put in an upright pulley in the way Mr MacFarlane describes, which necessitated a complete change of chain. That was one of the disadvantages of the chain. He expected Mr MacFarlane would have given them a few notes on the tail and single ropes with reference to their comparative costs.

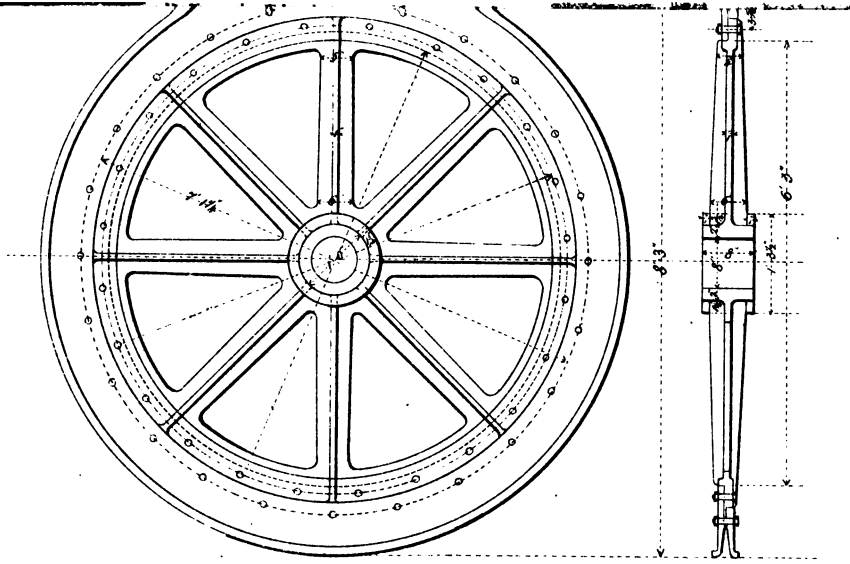
Mr MACFARLANE said he had not the tailrope at work at Allanton.

Mr RONALDSON said in reference to the pulley with the india-rubber in the bottom of the grove, he had frequently seen it at work, and from what he had seen he thought a great deal of it. He had only seen it on a small scale, but the india-rubber seemed to last a long time. He thought it was eighteen months since he first saw it, and in the case in point, his impression was that the original india-rubber in the bottom of the grove was still working. The engine which drove the haulage and pumping arrangement to which he referred was placed on the surface.

The endless rope itself took one half turn round the driving pulley, and the india-rubber in the bottom of the groove, was all the catch it had. Then it was taken down a dook, and another india-rubber-clad pulley at the bottom with a half turn of the rope served as a return pulley, and at the same time actuated a double-acting pump. It was only hauling out of the dook at present, but it seemed to work admirably. The gripping power of the india-rubber is wonderful; the greater the strain on the india-rubber the rope sinks the deeper into it, and has a greater catch.

The PRESIDENT said he believed the Thorncliffe pulley was sometimes used as a driving pulley, the rope acting simply as a belt.

The further discussion of Mr MacFarlane's paper was then adjourned till next monthly meeting.



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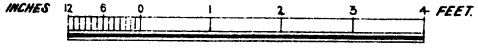
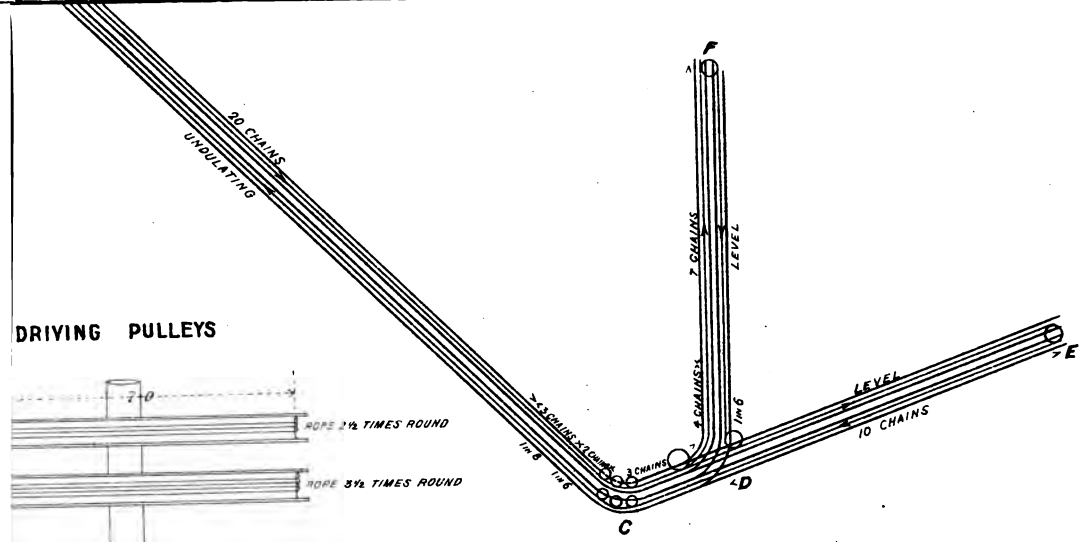
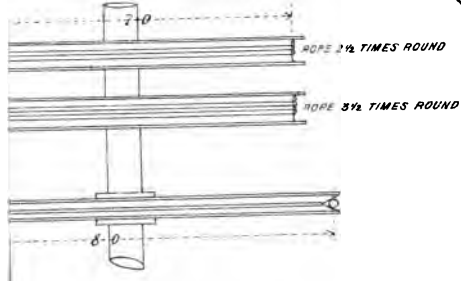




DRIVING PULLEYS



THE

MINING INSTITUTE

OF

SCOTLAND.

RULES,

AS REVISED AT A SPECIAL MEETING, 12TH MAY, 1881.

HAMILTON:
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1881.

THE MINING INSTITUTE OF SCOTLAND.

RULES,

AS REVISED AT A SPECIAL MEETING.

12th May, 1881.

SECTION I.—OBJECTS.

I.—The objects of this Institute are to enable its Members to meet together at fixed times to discuss the means for the ventilation of Coal and other Mines, the Winning and Working of Collieries and Mines, the Prevention of Accidents, and the Advancement of the Sciences of Mining and Engineering.

SECTION II.—CONSTITUTION.

I.—The Institute to consist of Ordinary Members, Life Members, and Honorary Members.

II.—The Council of the Institute for the management of its affairs shall be chosen annually from the Members, and shall consist of a President, Four Vice-Presidents, Twelve Councillors, a Secretary, and a Treasurer.

SECTION III.—QUALIFICATION OF MEMBERS.

I.—Ordinary Members to be persons practising as Colliery Managers, Mining, Civil, or Mechanical Engineers, and other persons connected with, or interested in, Mining and Engineering, of whom the Council may approve.

II.—Life Members to be persons who shall compound for all future payments by a payment of Ten Guineas, or on such conditions as the Council may in writing accept.

III.—Honorary Members to be persons of whom, although not technically qualified, the Council may approve.

Section IV.– Election and Expulsion of Members.

I.—A recommendation for admission, according to Form A, in the appendix, to be forwarded to the Secretary, and by him to be laid before the next meeting of the Council. The recommendation to be signed by Ordinary Members or Life Members.

II.—The Election to take place at a General or Special Meeting by ballot; three-fifths of the votes tendered being necessary for election.

III.—In the case of non-election, no mention thereof shall be made in the minutes, nor any notice given to the unsuccessful candidate.

IV.—When the proposed candidate is elected, the Secretary shall give him notice thereof, according to Form B, but his name shall not be added to the list of Ordinary Members or Honorary Members until, and unless, within two months after notice of election as above, he shall have paid his first annual subscription, and signed the form C, whereupon he shall be entitled to all privileges of Membership, including a copy of the Transactions issued in that year.

V.—The transactions of the Institute shall not be forwarded to persons whose subscriptions are more than six months in arrear.

VI.—Any person whose subscription is twelve months in arrear shall be reported to the Council, who shall direct application to be made for it, according to Form D, and in the event of its continuing one month in arrear after such application, the Council shall have the power, after suitable remonstrance by letter, in the form so provided (Form E), of erasing the name of the defaulter from the register of the Institute.

Section V.—Election of Officers.

I.—The election of Officers shall take place at the Annual General Meeting in the month of April in each year.

II.—The President, the Vice-Presidents, and Councillors to retire annually; but they shall be eligible for re-election with the exception of one Vice-President and the three Councillors who may have attended the fewest Council Meetings during the past year, and when such attendances are equal, the Council shall decide which of the Vice-Presidents and Councillors shall be re-nominated; but such persons shall be eligible for re-election after being one year out of office.

III.—Candidates to be put in nomination at the General Meeting preceding the Annual General Meeting, when the Council shall present a list of their retiring members who offer themselves for re-election. Any member to be entitled to add to the list of candidates. In case of the decease or resignation of any Officer or Officers, notice thereof must be given at the next General or Special Meeting, and a new Officer or Officers elected at the succeeding General or Special Meeting, in accordance with the mode above-mentioned.

IV.—The Secretary and Treasurer shall be appointed every year by the Council, at the first meeting of the Council after the Annual General Meeting.

Section VI.—Meetings.

I.—There shall be Twelve Ordinary General Meetings in each year, to be held in Hamilton, unless elsewhere arranged for by the Council, on the second Thursday in every month. The Annual General Meeting to be held in the month of April.

II.—A Special Meeting of the Institute to be called whenever the Council may think fit, and also on a requisition to the Council distinctly specifying the reason thereof, signed by ten members.

III.—The Ordinary Members, Life Members, and Honorary Members to have notice of, and the privilege to attend all General and Special Meetings (but Ordinary Members and Life Members only to be entitled to vote on any question by ballot or otherwise.)

IV.—Every question, not otherwise provided for, which shall come before any Meeting of the Institute, shall be decided by the votes of the majority of the Members and Life Members then present. But the Council shall have the discretionary power of suspending the effect of such decision, if by them considered to be prejudicial to the interests of the Institute; and of referring the same to a Special or to the next General Meeting, and at least ten days before such meeting, the Secretary shall have sent, by printed circular, to every person enrolled in the Institute, explicit notice of the question in abeyance.

V.—Invitations shall be forwarded by the Council to any gentleman whose presence at the discussion they may think advisable; and strangers so invited shall be permitted to take part in the proceedings, but not to vote.

VI.—Any person enrolled in the Institute shall have power to introduce a friend or stranger (see Form F) to any of the General Meetings of the Institute, but such visitor shall not take part in the proceedings, except by permission of the meeting.

VII.—No alteration of the Rules to be made at any but the Annual General Meeting, or at a Special Meeting for that purpose; and the particulars of every such alteration shall be announced at a previous General Meeting and inserted in the minutes; and such Annual or Special Meeting shall have power to adopt any modification of such proposed alteration of, or addition to, the Rules.

Section VII.—Subscriptions.

I.—The Annual Subscription of each Ordinary Member shall be 10s 6d, excepting Coalmasters, Agents, Civil, Mining, and Mechanical Engineers, and other Members interested in but not actively engaged in Mining, whose subscription shall be £1 1s.

II.—All Annual Subscriptions to be payable in advance, and the same are to be considered due and payable at the April meeting of each year, or immediately after election.

Section VIII.—Communications by Members.

I.—The Council shall direct whether any paper read before the

Institute shall be printed in the Transactions ; and notice shall be given to the writer within one week after it has been read, whether it is to be printed or not.

II.—The Council shall have the power to publish any or all of the communications as they may think proper.

III.—Three copies of each paper printed by the Institute shall be presented to the author for private use.

IV.—All proofs of discussion, forwarded to persons who have taken part therein for correction, must be returned to the Secretary within two days from the date of their receipt. otherwise they will be considered correct and be printed off.

V.—The Institute is not, as a body, responsible for the facts and opinions advanced in the papers which may be read, and in the discussions which may take place at the meetings of the Institute.

The copywright of all papers communicated to, and accepted for printing by the Council and printed within twelve months, shall become vested in the Institute, and such communications shall not be published for sale or otherwise without the written permission of the Council.

Section IX.—Duties of the Officers and Council.

I.—The President to be Chairman at all Meetings, and, in his absence, one of the Vice-Presidents. In the absence of a Vice-President, the Members present to elect a Chairman for that Meeting.

II.—The Funds of the Institute shall be deposited in the hands of the Treasurer, and shall be disbursed or invested by him according to the direction of the Council.

III.—The Secretary shall be present at all the Meetings, and shall take minutes of the proceedings and read those of the preceding Meeting ; but in the case of unavoidable absence, the Council to appoint some one to act for him.

IV.—All past Presidents shall be *ex officio* Members of the Council so long as they continue Members of the Institute; and Vice-Presidents, not re-elected, shall be *ex officio* Members of the Council for the following year.

V.—At Meetings of the Council five shall be a quorum, and the minutes of the Council's proceedings shall be at all times open to the inspection of the Members of the Institute. The President shall be *ex officio* chairman of every committee.

VI.—The Council shall have power to revise and correct proofs of communications and the discussions thereon, and to delete any portion or portions of the discussion which may be by them deemed unsuitable for publication.

VII.—At the Annual General Meeting the Council shall present a report of the proceedings, and an abstract of the accounts of the previous year, audited by two Ordinary Members who are not Members of the Council.

Section X.—Property of the Institute.

I.—All the Property of the Institute to be held by the Council in trust for the Institute.

II.—All Books, Drawings, Communications, &c., shall be accessible to all the Members of the Institute; and shall be held in trust by the Council, at the Rooms of the Institute in Hamilton, for the use of the Members.

III.—None of the property of the Institute, as Books, Drawings, &c., to be taken out of the Rooms of the Institute without the consent of the Council.

IV.—No duplicate copies of any portion of the Transactions shall be issued to any of the Members or others, unless by written order from the Council.

V.—All donations to the Institute shall be enumerated in the Annual Report of the Council to the Members.

Section XI.—Disputes.

I.—Any difference of opinion arising regarding the interpretation of any of the foregoing Rules to be submitted to the Council, whose decision shall be final.

BYE-LAWS.

I.—The General Meetings to be conducted, as far as practicable, in the following order :—

1st.—The chair to be taken at Six p.m.

2d.—The minutes of the previous meeting to be read by the Secretary or person appointed, and, after being confirmed, to be signed by the Chairman of that meeting.

3rd.—The balloting of new nominations for membership shall be proceeded with and the result announced.

4th.—Communications by letter to be read by the Secretary, according to priority of date.

5th.—Communications from the Council to be read by the Secretary.

6th.—Discussion will be invited upon a paper or papers read at a previous meeting, copies of which, if printed, will have been circulated among the members.

7th.—The paper or papers announced for the meeting will be read.

8th.—With a view to the maintenance of order during discussions and to prevent them from degenerating into mere conversations, no remarks will be considered in order unless the speaker is standing.

II.—Any member changing his residence to give notice in writing to the Secretary.

APPENDIX.

[FORM A.]

Name in full, Mr
Designation or occupation,
Address,
being desirous of admission into the Mining Institute of Scotland, we, the undersigned, propose and recommend that he shall become a thereof.

Proposed by { } Signature of two Members.

Dated . 18

See Rules.
Section III.—Qualification of Members.
Section IV.—Articles I. and II.—Election of Members.

[FORM B.]

SIR,—I beg to inform you, that on the day of you were elected a of the Mining Institute of Scotland; but, in conformity with its Rules, your election cannot be confirmed until the enclosed Form be returned to me with your signature, and until your first annual subscription, £ , be paid.

If not paid within two months from this date, the election will be void, under Rule IV., Section IV.

I am, Sir,
Yours faithfully,

Secretary.

Dated, 18

[FORM C.]

I, the undersigned, being elected an of the Mining Institute of Scotland, do hereby agree that I will be governed by the regulations of the said Institute as they are now formed, or as they may be hereafter altered; that I will advance the objects of the Institute as far as shall be in my power, and will not aid in any unauthorised publication of the proceedings, and will attend the meetings thereof as often as I conveniently can, provided that whenever I signify in writing to the Secretary that I am desirous of withdrawing my name therefrom, I shall (after the payment of any arrears which may be due by me at that period), be free from this obligation.

Witness my hand this day of 18

Signature.

[FORM D.]

I am directed by the Council of the Mining Institute of Scotland to draw your attention to Rule VI., Section IV., and to remind you that the sum of £ of your annual subscription remains unpaid and that you are, in consequence, in arrear of subscription. I am also directed to request that you will cause the same to be paid without further delay.

I am, Sir,
Yours faithfully,

Secretary.

Dated, 18

[FORM E.]

SIR,—I am directed by the Council of the Mining Institute of Scotland to inform you that in consequence of your arrears of subscription, and in pursuance of Rule VI., Section IV., the Council have declared by special vote, on the day of 18 , that you have forfeited your claim to belong to the Institute, and your name will be, in consequence, expunged from the Register, unless payment is made previous to 18

I am, Sir,
Yours faithfully,

Secretary.

Dated, 18

[FORM F.]

Admit
of
to the Meeting on Thursday, the
Signature of Member
The chair to be taken at Six P.M.

I undertake to abide by the regulations of the Mining Institute of Scotland, and not to aid in any unauthorised publication of the proceedings.

Signature of Visitor,

Not transferable.

The Mining Institute of Scotland.

1881-82.

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37. Brown, Thomas M., Lanemark Colliery, New Cumnock.
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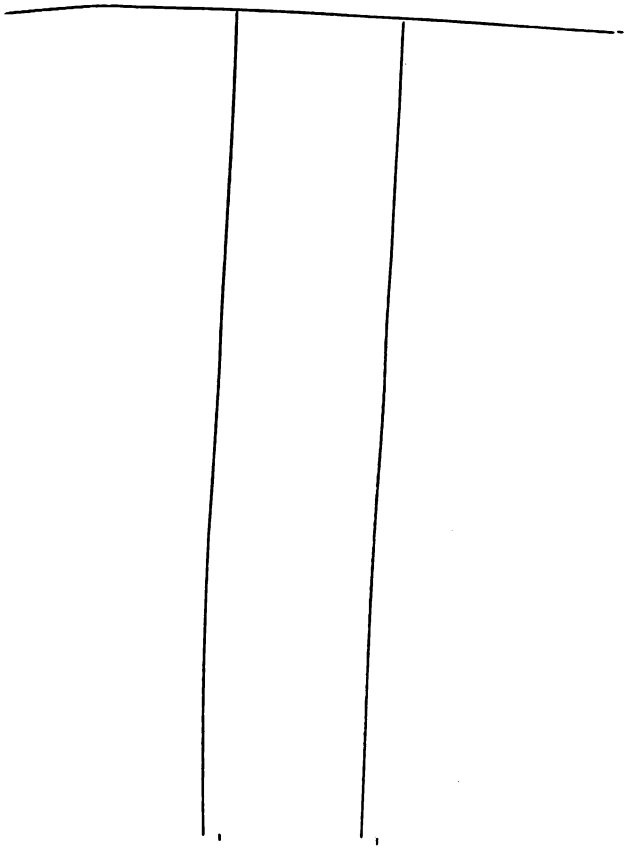

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